DEPRIVATION IN PARADISE:

IDENTIFYING O‘AHU FOOD DESERTS

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI‘I AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

IN

GEOGRAPHY

MAY 2017

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Keywords: Food Deserts, Food Security, O‘ahu

ACKNOWLEDGEMENTS

I would like to thank my family and friends, especially my parents for their continued financial and emotional support and my Aunty Mary and Patsy for allowing me to live with them during my academic studies. I would also like to thank my mom, cousin Angela, and friends Ayesha and Anna for helping me with the basket compilation and editing. Thank you to my committee for their continued support and the Department of Public Health, particularly Dr. Victoria Fan, for providing me with the tools to complete this analysis.

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CHAPTER 1. INTRODUCTION

The term "food desert" was created in the 1990s by the United Kingdom's Low Income Project team to describe deprived, poverty stricken areas with limited healthy food choices, and became a metaphor resonating with policymakers to describe areas of limited access to healthy foods (Cummins, 2002, Apparicio et al., 2007, Shaw, 2006, Beaulac et al., 2009, Wrigley et al., 2002, Wrigley et al., 2004). One of the first studies of food deserts, Wrigley et al., (2002), measured consumption patterns and food security through participant testimonials at the Seacroft, Leeds project area to determine factors noted by participants to inhibit access. They determined that physical access is not always the determining factor in where and types of foods to purchase (Wrigley et al., 2002, Wrigley et al., 2004).

There is an uneven distribution of food resources in the US, dependent on location and socioeconomic status, variety and quality of foods available, and economic means (Smith and Morton, 2009). The USDA defines food security as "access by all people at all times for an active, healthy lifestyle," ranging from high, marginal, low, and very low. Organizations like the Community Food Security Coalition and Wisconsin Food Security Project define food security by focusing on affordable, nutritionally adequate, culturally acceptable, and high quality foods through local and non-emergency sources (Short et al., 2007, Hallett and McDermott, 2011, Shaw, 2006). The Wisconsin Food Security Project refines the definition by including characteristics like low-income, ethnic minority, high-unemployment, low car ownership, and limited healthy retailing choices (Shaw, 2006).

In 2014, 14 percent of all households in the US experienced low food security and 5.6 percent of all households experienced very low food security (Coleman-Jensen et al., 2014); one in five households of these households had children, one in three were low income, and over half

were single parent households. Between 2012 and 2014 the USDA reported that Hawaii had above average access to food, with only about 12.3 percent of households with low or very low food security but in 2015, 16.7 percent of all Hawaii households were reported by the State Department of Health to have low or very low food security (Hawaii Health Matters, 2016), and over 20 percent were at risk of being food insecure (Chirico and Farley, 2015). The groups with the most vulnerability in food security include households with children, poorer households, single parent households, and Native Hawaiians/Pacific Islanders with the most vulnerable communities on Oahu located in Waimanalo, Waianae, and Kaaawa (Hawaii Health Matters, 2016, Chirico and Farley, 2015).

The USDA provides the Food Environment Atlas to measure factors like proximity to food stores, prices, nutrition assistance programs, and socioeconomic characteristics to measure access and diet quality in these areas. The purpose of the atlas is to assemble statistics to uncover determinants of food choices and provide a spatial overview of access in communities. The USDA Food Environment Access tool is only available for the 48 contiguous states, leaving gaps in measuring access in Hawaii (Hawaii Health Matters, 2016). As George Kent noted in his chapter of *Thinking Like an Island: Navigating a Sustainable Future in Hawaii* much of the focus on food accessibility in Hawaii has been on the overall food supply rather than access within specific socioeconomic groups and communities like those living in poverty, a problem prevalent in Native Hawaiian communities (Chirico and Farley, 2015).

Public health researchers argue that neighborhoods with adequate access to healthy food retailers such as supermarkets have healthier diets and lower levels of obesity. But what constitutes access? The lack of analyses regarding community access and food deserts in Hawaii

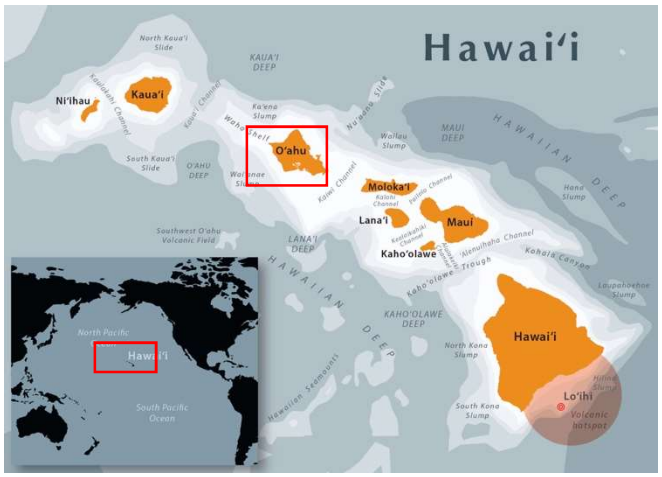
drove this research. This thesis is an attempt to examine the food desert notion and to model the phenomenon on the island of Oahu.

1.1 The Research Question and Purpose of Study

The question guiding this research is: How does access to healthy food on Oahu shift when considering food costs, proximity to supermarkets, and community socioeconomic characteristics? The purpose of this study is to test a model to determine which areas on Oahu have the greatest challenge regarding access to healthy food, in supermarkets, determined by distance, food costs, and socioeconomic characteristics.

1.2 Study Area

The fiftieth state of Hawaii consists of eight islands, seven of which are inhabited by nearly 1.5 million people as of July 2016 (US Census Bureau). Oahu is the most populous of the islands, with nearly 1 million residents, or two-thirds of the state's population, and increased its population by about five percent between 2010 and 2015. Besides being the most populous island in the chain, it is also the most densely populated. Oahu was selected as the study area because of the availability of data from the State of Hawaii as well as City and County of Honolulu. The location of the State of Hawaii is displayed in Map 1.



Map 1. Map of Hawaii. Image obtained from Wikipedia.org and Map Bliss.

1.3 Methodology and Document Organization

To answer the research question, a set of objectives were created to identify areas that would be considered food deserts through this modeling exercise:

1) Where are households and supermarkets located on Oahu, and how far do residents need to travel to supermarkets?
2) What is the cost of a basket of goods at each supermarket?
3) Which areas lack access as a function of proximity and food costs?
4) Which areas are the most socioeconomically vulnerable using variables determined in the literature?
5) As a combination of physical proximity and socioeconomic vulnerability, which areas are modelled as food deserts on Oahu?

The document is divided into four chapters following the introduction: literature review, methodology, results and discussion, and conclusion. The second chapter, literature review, of this research focuses on identifying: 1) GIS methodologies employed by other researcher to model or identify food deserts, 2) socioeconomic variables consistently mentioned throughout the literature as connected to food deserts, and 3) how other researchers used the market basket in food desert studies.

The methodology utilizes the techniques and variables gathered in the literature review to answer questions where residences and supermarkets are located, what are the distances between entities, what are the costs of a basket of goods, which areas lack access in terms of proximity, and which areas are the most socioeconomically vulnerable. This data was created by generating household and store location data then performing network analyses for households and

supermarkets, visiting stores to generate prices for a basket of foods, compiling socioeconomic data, then overlaying physical, cost, and socioeconomic data in GIS.

The results of overlaying socioeconomic, cost, and physical measures data were noted, discussed and critiqued in the results and discussion section of this research. It is important to note that this research is a modelling exercise to examine the influence of socioeconomic status, physical distance, and food costs, and not intended to diagnose which areas have impediments in obtaining healthy foods.

The conclusion and concluding chapter summarizes the research and situates the research with other projects occurring at the University of Hawaii at Manoa. There is also personal testimony relating to the critiques within the results section of this report.

CHAPTER 2. LITERATURE REVIEW

This chapter synthesizes literature describing food security, how food deserts are described and what controversies surround the term, and what methods (particularly in GIS) have been used to map and measure food deserts. The literature review was vital in identifying how to utilize GIS to identify food deserts and what variables are correlated with food deserts. Identifying methodologies used to identify food deserts is crucial in understanding how GIS can be utilized to identify these areas, how this research could build upon what was previously completed, and how to combine physical and socioeconomic measures of access. The literature review was important in solidifying which variables to use; variables most consistently mentioned throughout the literature were deemed most important while others that were mentioned in passing where given less weight. The studies that did not utilize GIS are summarized in Table 1 and the studies that utilized GIS are summarized in Table 2.

2.1. The Role of Geography

Places impact people's behaviors, experiences, choices, and health (MacIntyre et al., 2002). There has been an interest in linking health outcomes to a lack of access to healthy foods, where access is a combination of factors like socioeconomics, food quality, and transportation (Horner and Wood, 2014). Geography is important in health studies as researchers look to connect the built environment, and community health (McEntee and Agyeman, 2010, Gatrell, 2011).

Geospatial methods in public health studies were borne from the need for researchers to incorporate spatial data in health studies at various scales (McKinnon et al., 2009). Duvall et al. (2010) argue that the built environment impacts dietary choices and community health, especially in socioeconomically disadvantaged areas lacking access to healthy, and varied food

establishments. Many recent food desert studies have taken a spatial approach in identifying and measuring where access to healthy food is limited (Coveney and O'Dwyer, 2009). The challenge of defining levels of food access with socioeconomic access created "areas of relative exclusion where people experience physical and economic barriers to accessing healthy foods," known as "food deserts" (McKinnon et al., 2009).

A "new public health" developed by connecting health studies and spatial analyses through utilizing Geographic Information Science (GIS). This connected theorists and practitioners, as well as structural and environmental influences on health and behavior regarding health inequality. As GIS software become widely available, richer analyses using databases, network, and multi-scale analyses, enabled researchers to study data not previously seen to have a spatial component (Charreire, et al., 2010, McEntee and Agyeman, 2010).

2.2 Food Security

Poverty is one of the greatest inhibitors to food security, particularly between healthy and unhealthy food products, and can lead to undernutrition (not enough food) or over nutrition (over-consumption of unhealthy food) (Hough and Sosa, 2015, Eckert and Shetty 2011, Smoyer-Tomic et al., 2006, LeClair and Aksan, 2014). Analyses have investigated access as measured by proximity, leading to preemptive policies focused solely on physical access. While physical access is an important concept, it is irresponsible to claim it is the only impediment regarding access (Widener and Shannon, 2014).

Preference is a component of food security, and includes characteristics like familiarity, convenience, nutritional quality, enjoyment, and cost. At times, unhealthy food is eaten due to enjoyment in social situations, cultural preferences, or as stress relief. Cook et al. (2011) note some would prefer to purchase the healthier products, like organic fruits and vegetables, but lack

financial means; however, they also note that some poorer consumers may prioritize these products for health reasons (Cook et al., 2011). Information access regarding nutrition can be a mechanism of food security (Hough and Sosa, 2015) but some have glamorized food "prioritization" as studies have demonstrated people with limited means typically eat fewer fruits and vegetables due to cost concerns (Guy and David, 2004, Coveney and O'Dwyer, 2009).

Some studies measure all establishments as equal, though entities like supermarkets are associated with better diets due to the variety of cheaper, higher quality food but are absent in poorer communities (Powell et al., 2007, Widener and Shannon, 2014, Eckert and Shetty, 2011, Larson et al., 2009). Since the 1970s, supermarkets and big box retailers have fled from the urban core to the suburbs because of the availability of larger tracts of land enabling retailers to build larger, cheaper, and fewer facilities (Larsen and Gilliland, 2008, Pothukuchi, 2005, Sadler et al., 2011). A variety of retailing became available for wealthier consumers in the suburbs but left a deprived urban core (Larsen and Gilliland, 2008, Pothukuchi, 2005). Many smaller grocers collapsed as they were unable to compete with the prices and varieties of supermarkets, thus creating more communities with impeded access to food retailing (Smoyer-Tomic et al., 2006, Sadler et al., 2011). To alleviate gaps in access, alternatives such as farmer's markets have been discussed but little research has addressed their impact (Wang et al., 2014). Smith and Morton argue that these shifts in a community's food systems, like limited retailing opportunities created food deserts (Smith and Morton, 2009).

Food security has become an important topic in planning as more health studies note the built environment impacts access, particularly in low-income communities (Shaw, 2006) but supermarket locations have been a private market issue and the government has only intervened through agricultural subsidies and consumer food assistance programs. Planners have attempted

to attract supermarkets to inner cities though the movement is not widespread (Shaw, 2006). Food deserts are the product of underlying social and economic forces pertaining to the feasibility of retail development in areas, transportation, and demographics of consumers (Larsen and Gilliland, 2008, Leete et al., 2012, Hallett and McDermott, 2011). Access to retailing facilities is a rudimentary solution, questioning whether supermarkets are the problem and food deserts are merely the symptom (Cummins, 2002, Russell and Heidikamp, 2011, Walker et al., 2010).

2.3 The USDA Food Access Research Atlas

In 2008, the USDA defined food deserts in the US as areas with limited access to affordable and nutritious foods in predominantly lower income neighborhoods in the 2008 Farm Bill Section 7427 (Leete et al., 2012). The USDA developed the Food Research Atlas to display access indicators for low-income census tracts using levels of supermarket access within tracts for all the US (ERS USDA Food Access Research Atlas).

The USDA explains the terms and methods used including determining which stores to use (i.e., must receive SNAP), low income census tracts, low access, and how food deserts are defined. Low income tracts were defined as: 1) more than 20 percent of the population is living below poverty (a measure used in this research), 2) the tract median income is less than or equal to 80 percent of the state median income, and 3) the tract is in a metro area with a median family income below 80 percent of the metro median income. Low access is defined as areas "far from supermarkets, supercenters, large grocery stores" with access varying from 0.5 to 1 mile for urban areas and 10 to 20 miles for rural areas. Households were located using aerial imagery and access was determined by dividing the areas into 0.5 kilometer grids to determine proximity to food establishments. The USDA defines Food deserts as areas where low income and low access

intersect. Additional tract-level indicators of access provided include: 1) vehicle availability, 2) group quarters, 3) tract level characteristics (population, low-income, urban/rural status, number of housing units), 4) low income/access and distance measures – percentage low income and/or low access households at distance thresholds (i.e., ½, 1, 10, and 20 miles), and 5) subgroups such as children and seniors.

The atlas allows users to investigate socioeconomic data with several mechanisms to measure food deserts: 1) access measured by distance, 2) access measured by concentration of stores, 3) individual resource allocation (e.g., family income), 4) neighborhood indicators of resources (i.e., average neighborhood income), and 5) whether a significant number of housing units are far from supermarkets. Demarcation levels were at the 0.5 and 1 mile levels for urban, and 10 and 20 mile levels for rural areas assuming vehicle accessibility.

2.4 The Market Basket, Thrifty Food Plan, and Government Assistance

The USDA provides four meal plans (i.e., thrifty, low-cost, moderate-cost, and liberal) to accommodate a range of budgets, with a total of fifteen baskets per meal plan, one for each gender/age group; it is part of the US food guidance system, regulated by the USDA's Food and Nutrition Service, Economic Research Services, and Agricultural Research Service (ERS ARS). The Thrifty Food Plan provides the basis for determining the maximum food stamp allotment and provides a "representative healthful and minimal cost meal plan that shows how a nutritious diet may be achieved with limited resources." Its goal is providing nutritious options for low income individuals, at or below 130 percent of the US poverty threshold which is the gross-income cutoff for food stamp eligibility (USDA ERS, 2006).

The TFP is based on: Dietary Guidelines for Americans, the MyPyramid Food Guidance System, prices paid by low-income households, food consumption data, nutrient content, and

prices provided by retailers, while offering a realistic reflection of time available for food preparation, but is outdated with the last publishing in 2006 (Carlson et al., 2007). Two data sets are used in compiling the TFP: the federal government's National Health and Nutrition Examination Survey and the Food Price Database. The National Health Survey provides information on consumption patterns of foods and health data within various socioeconomic groups in the US. The survey is used to make a market basket generated by the AcNielsen Homescane™ Panel which produces the Food Price Database, excluding Hawaii.

Dietary habits vary across socioeconomic statuses, but are a function of food choices, physical access, availability, and prices. Food prices are said to have the largest impact on food selection, especially regarding fruits and vegetables, within mid- to low-income households who are most sensitive to prices as a proportion of their disposable income (Lin et al., 2014). Consumption of healthy products is associated with larger budgets, therefore, price reductions and assistance programs such as SNAP and WIC increase consumption of healthy foods, particularly fresh fruits and vegetables in low-income households (Breyer and Voss-Andreae, 2013). Lin et al. (2014) provided an analysis of SNAP participants' consumption patterns and impediments in obtaining foods. They found that poorer households struggled with purchasing fresh fruits and vegetables, though not statistically significant compared to households claiming to not have financial impediments. Lin et al. claim that distance is the greatest impediment in obtaining healthier foods, possibly because of perishability and lack of motivation or ability to purchase foods regularly (Lin et al., 2014). In Smith and Morton (2009), people living in rural food deserts were interviewed regarding food consumption patterns and participants acknowledged healthy foods as important but unattainable due to the cost. Rural communities faced challenges with limited transportation, and lack of retail variety, whom they felt did not

competitively price goods. However, some food choices depended on preference due to taste and what other household members (especially children) would also consume (Smith and Morton, 2009).

Market basket studies assess food availability, prices, and quality and based on the USDA TFP; establishments can be compared by costs, availability, and quality of goods. Smaller stores had fewer, and more expensive healthy items (Jetter and Cassady, 2006). Despite the differential, Breyer and Voss-Andreae emphasized the selection of healthier, whole foods in their analysis to accommodate health conscious, but financially constrained consumers (Breyer and Voss-Andreae, 2013), an approach used in this research.

2.5 Conceptualizing Food Deserts

The definition of a food desert has been expanded in research by noting the significance of economic access (Leete et al., 2012, Whelan et al., 2002, Russell and Heidikamp, 2011, Larsen and Gilliland, 2008, Jiao, 2012). Socioeconomic factors are related to and are compounded by a lack of physical access (i.e., proximity) and quality (i.e., healthy, affordable, and culturally adequate). Mobility is restricted by factors like physical capability to travel, transportation access, and affordability (Raja et al., 2008, Leete et al., 2012, Whelan et al., 2002, Russell and Heidikamp, 2011, Larsen and Gilliland, 2008, Jiao, 2012, LeClair and Aksan, 2014, Coveney and O'Dwyer, 2009, Sadler et al., 2011, Larsen and Gilliland, 2009, Widener and Shannon, 2014). Food deserts have become a proxy regarding equitable food access, particularly within urban communities in North America (Breyer and Voss-Andreae, 2013).

Food deserts are controversial due to the lack of consensus in identifying them, creating debates as to whether they exist in developed countries, particularly outside the US (Apparicio et al., 2007, Walker et al., 2010). Though there is no universal definition of food deserts, the term

signifies areas with limited access to food retailing but defining access has been a conflict amongst and between researchers and policymakers (Eckert and Shetty, 2011). Researchers develop their own working definitions of food deserts emphasizing physical and economic barriers to amenities and infrastructure, contributing to an unhealthy diet (Beaulac et al., 2009, Pearce et al., 2006, Pearson et al., 2005, and Shaw, 2006, Walker et al., 2010). 2.5.1. Current debates regarding food deserts

2.5.1. Current Debates Regarding Food Deserts

Debates surrounding food deserts question the causes and implications of deeming an area a food desert and critics do not believe that physical access is the only impediment as prices are also an inhibition many face. The food desert counterpart "food mirages," has received less attention despite providing a needed contrast to the term. Breyer and Voss-Andreae (2013) defined food mirages as areas appearing to have access to resources but invisible impediments, such as economics, are present (Breyer and Voss-Andreae, 2013).

Increasing geographic access does not improve access if people cannot afford or have no desire to purchase items and researchers emphasized the importance of socioeconomics, particularly how purchasing power impacts choices. McEntee and Agyeman (2010) consider geographic, economic, and informational factors regarding access; particularly the combination of food and transportation costs. Informational access, or factors relating educational, cultural, and social constraints influencing how and why people choose to eat certain foods, partially explaining why people select certain foods and retailers (McEntee and Agyeman, 2010).

The term food desert appeared in popular culture, such as The New York Times and The Chicago Tribune, which reported that many poor urban neighborhoods lack adequate access to food retail facilities, arguing that these neighborhoods were "swamped" with convenience stores,

supermarkets, and retailers (Kolata, 2012, Bornstein, 2012). The authors note that people choose unhealthy products due to desire not necessity, criticizing efforts of increasing the number of stores as an attempt to produce a "magic bullet" (Kolata, 2012) to "combat the obesity epidemic simply by improving [physical] access to healthy foods" (Bornstein, 2012). In 2015, attitudes at The New York Times towards food deserts had not changed. Journalist Margot Sanger-Katz reported that in the Bronx, New York supermarket availability improved physical access but there were no changes regarding food prices or preferences of consumers. Sanger-Katz argues that consumer preference and taste dominate food selection (Sanger-Katz, 2015).

2.5.2 Characterizing Food Deserts using GIS

Food desert characteristics have been used interchangeably with characteristics of communities lacking food security. Shaw describes access in three terms: 1) ability – physical inhibitions, 2) assets – financial inhibitions, and 3) attitude – state of mind preventing consumers from accessing foods they could otherwise physically bring into their home. Geographic methodologies employed by researchers to determine areas of deprivation enable the connection of the three terms described by Shaw by combining geographic and socioeconomic access with the quality of products available to consumers. Larson et al., 2009 analyzed 54 articles pertaining to access and reported that most spatial analyses focused on determining food access utilizing GIS. The scales varied from census areas (e.g., tracts, blocks), area types (e.g., urban, counties), specific socioeconomic characteristics (e.g., ethnic minority communities), and individual households (Larson et al., 2009). Several researchers utilized GIS to overlay socioeconomic characteristics with physical access, while others focused on the quality of products with geographic access. The studies that utilized GIS to determine access are summarized in Table 2.

Several studies utilize GIS to compare store locations to other entities, but did not utilize the road network such as Shaw (2006), which divided areas into grids to determine which had access to fresh foods, and Hallett and McDermott (2011), which generated a cost-surface measuring the cost of traversing each cell from households to stores. Other studies overlaid data such as in Larsen and Gilliland (2009), which compared supermarket locations to farmer's markets to model access, Powell et al. (2007) which used multi-variate analyses to associate store availability and socioeconomic characteristics, and Morland et al. (2002) which overlaid store locations and types with socioeconomic and health data. Studies such as Duvall et al., 2010 and Guy and David (2004) used GIS to determine the availability of healthy products (e.g., fruits and vegetables) within communities, through surveying the availability and cost of products. Morland et al. (2006) focused on utilizing GIS to display the density of stores in census tracts, then overlaid the findings with socioeconomic data.

Most of the literature reviewed utilized the road network to determine distances to resources. Network analysis examines the structure and properties governing flows of materials or information between nodes in a system (CDC, Network Analysis Tools). Topological data structures were the earliest mechanisms of network analysis where start and end-points (nodes) and their connections (edges), determined the connectivity of a system. The introduction of topological data models facilitated many GIS functions, enabling the creation of the Dual Independent Map Encoding (DIME), capturing information between nodes and along lines. This developed into the Topologically Integrated Geographic Encoding and Referencing (TIGER) borne from the Census Bureau's need to capture information of transportation networks in the United States is still in use. Today network models are used in transportation routing (Curtin,

2007). Studies use network analysis to determine physical access at community or consumer levels, or a combination of the two (MacIntyre et al., 2002).

Some researchers measured access in communities with specific socioeconomic profiles such as low-income and ethnic minority neighborhoods. This was present in Smoyer-Tomic et al. (2006), which measured access in different lower-income inner city clusters, and Raja et al. (2008) which determined access in neighborhoods (i.e., block groups) of color. McEntee and Agyeman (2010) utilized GIS to determine distances between supermarkets and rural residential units, then aggregated the data to census tracts to determine food deserts.

Numerous researchers considered access by food store type such as farmer's markets (Wang et al., 2014), chain supermarkets (Coveney and O'Dwyer, 2009 and Russell and Heidikamp, 2011), fast food establishments (Pearce et al., 2007), or a combination of multiple store types (Gordon et al, 2011 and Sadler et al., 2011). Other studies focused on the correlation between residences and fresh food availability. Eckert and Shetty (2011) measured distances from stores carrying fresh food to residences. Pearson et al. (2005) utilized information gathered in questionnaires with GIS derived distances to measure food consumption particularly produce.

Several studies utilized measures of proximity in conjunction with measures of density to determine access such as in Jiao (2012), which determined access varying scales, Apparacio et al. (2007), which considered the density of food establishments, distances between block centroids, and the three nearest establishments for each census block, and Leete et al. (2012) which combined proximity, density of store locations, and the concentration of poverty, to determine access.

Other studies provided a range of analyses that incorporated socioeconomic variables such as in Larsen et al. (2008), which used GIS to measure physical access and overlay

socioeconomic variables (e.g., low income). Pearce et al. (2006) measured access to crucial resources for a healthy lifestyle, like healthy food, by measuring distances between establishments and meshblock centroids. Further studies used the combination of proximity and economics to determine access such as in LeClair and Aksan (2014), which generated a time cost by multiplying distances by the minimum wage to demonstrate that greater distances imply greater costs for consumers. Breyer and Voss-Andreae (2013) used distances to residences and costs to determine access by using a variation of the Thrifty Food Plan to model purchasing by health conscious but price sensitive shoppers and use a combination of proximity and density measures in relation to the products available at each establishment.

2.6 Data Overlay and Determining Food Deserts in ArcGIS

GIS software enables users to overlay features producing a cell-by-cell analysis noting that "values in each input data layer are associated with a specific combination of additional variables" recorded in an attribute table (Bolstad, 2005). The overlay analysis in ArcGIS enables users to apply weights to diverse inputs and overlay them to create a single integrated output. Its basis is similar to the analytical hierarchy process which is a structured decision making process utilizing evidentiary support, through research or observations, to generate and analyze complex decisions; its objective is to make better decisions using given criteria (Saaty, 2006, Saaty, 2008, Erden 2010).

Overlay analysis begins with defining the problem, identifying objectives, and determining which objectives are competitive or complementary. The problem is divided into submodels to control the complexity and determine data necessary for each step; reclassifying and transforming data into proper formats (i.e., raster) into a common measurement scale is essential. The overlay tool compiles the data by weights based on a model of relationships between

variables. To complete this, an evaluation scale needs to be created and consistent amongst all data (ESRI Help, "How Weighted Overlay Works"). The results can be analyzed to note relationships between variables. There are three overlay approaches within the ArcGIS platform: weighted overlay, weighted sum, and fuzzy overlay. The weighted overlay and weighted sum functions were used in this analysis.

The weighted overlay analysis overlays rasters using a common measurement scale, weighted by importance and weights of all variables summing to 100 percent. Scales must be integers and classified based on a predefined scale (e.g. 1 to 5) with unwanted values reclassified as "restricted" and higher values representing favorable choices, relative to one another where 5 is five-times as favorable as a value of 1. Preferred values should be consistent between rasters, so a preference of "5" should mean the same between rasters, though specific variables can be weighted more heavily.

The weighted sum function enables the overlay of several raster data sets, however, unlike the weighted overlay analysis, the weighted sum function does not rescale reclassified values to an evaluation scale. Thus, rather than categorizing data, the resulting overlay produces floating-point values pertaining to the overlay in a gradient (ESRI Help, "How Weighted Overlay Works"). The fuzzy overlay analysis corresponds to data organized into classes (ESRI Help, "How Weighted Overlay Works").

Using an approach like the overlay function in ArcGIS, Bell et al. (2007) created a deprivation index from family demographics variables: elderly, single-dwellers, single parent/divorced/widowed households, young (i.e., under 5 years), overcrowded (i.e., more than five occupants), and transient households (i.e., those living in their home less than five years). They weighted variables by the number of times the variable was mentioned in the literature.

Gould et al. (2012) characterized neighborhood food environments by socioeconomic and physical access. Physical measurements were overlaid with variables to calculate a socioeconomic deprivation index including variables like median household income. The result was clusters of access where areas were determined to have differing levels of access (Gould et al., 2012); his approach was used in proceeding sections.

Table 1. Variables summarized by authors not using GIS to identify food deserts.

Author	Variables
Beaulac et al., 2009	Ethnic minority, low income, transportation
Jiao et al, 2012	Low income
Larsen et al., 2009	Neighborhood income, minority, higher percentage of free school lunch eligibility, higher poverty, lower education attainment, lower income
MacIntyre et al, 2002	Unemployment, car access, non-home ownership, employment rates, housing tenure, poverty, above 55 years old, race, education attainment, marital status
Walker et al., 2010	Minority and low income
Whelan et al., 2002	Elderly, disabled, minority, young mothers, lack transportation, single parent households, high unemployment, low education attainment, immigration
Wrigley et al., 2004	Young, young mother, public housing dependent, households with young children, low income, low access to transportation

Table 2. Variables summarized by authors GIS to identify food deserts.

Reference	GIS Analysis Type	Actions taken	Summary/Findings
Shaw, 2006	Grid analysis	Created grids (250x250 meter for urban and 500x500 meter for rural) to measure fresh produce availability within them	Socioeconomic variables associated with food deserts: Low income, high poverty, African American, and low car ownership
Hallett and McDermott, 2011	Cost-Surface Analysis	Measure physical distance from households to stores	Researchers measured the cost of traversing each cell using the lowest cost-path from households to stores Researchers surveyed households to determine transportation methods and distance to obtain foods.
Larsen and Gilliland, 2009	Overlay	Compared the location of supermarkets vs farmer's markets in urbanized areas	Farmer's markets provide a cost-saving opportunity but limited availability didn't improve overall access Socioeconomic variables associated with food deserts: Automobile access, low income, and ethnic minority
Powell et al., 2007	Geocoding/multi-variate analysis	Categorized food stores (e.g., chain/non-chain supermarkets, grocery stores, convenience stores)	Researchers used multivariate analysis to compare the location food store types against socioeconomic variables: income, ethnic minority, automobile access. Lower income neighborhoods have fewer chain stores and more non-chain grocers while middle-income neighborhoods have more chain stores
Duvall et al., 2010	Cluster/Mapping by foods available	Mapped stores by the products available	Displayed availability of healthy products within areas Found that larger supermarkets had more products but smaller (ethnic markets) fill in gaps
Guy and David, 2004	Mapping by foods available	Mapped stores by the products available	Used GIS to map locations of food stores by products Conclusion: superstores and discount stores were cheaper and had the largest variety but smaller grocers fill voids

Reference	GIS Analysis Type	Actions taken	Summary/Findings
Morland et al., 2006	Density	Measured density of stores in census tracts	Determined that areas with less access to supermarkets had better access to fast food stores Variables associated with low access: minority, female headed household, minors and elderly, low income, and low education attainment
Morland et al., 2002	Density /Overlay	Measured density of stores within census tracts	Categorized and mapped stores by census tracts then overlaid socioeconomic and health data Found that neighborhood characteristics are better indicators of access versus individual wealth: median community income and home value, and ethnic minorities
Smoyer-Tomic et al., 2006	Network Analysis	Compared the location of supermarkets to low-income, inner city neighborhoods (1-kilometer buffer around postal code centroids)	Supermarkets are typically along major road networks Access is better in central neighborhoods which are typically low income and lack vehicle access. Groups usually with lower access: Low-income, inner city, ethnic minority, poor, and lack private vehicle access.
Raja et al., 2008	Network Analysis	Measured supermarket access in neighborhoods (e.g., census block groups) of color	Measure neighborhoods of color access to grocers (5-minute automobile travel time) Finding: African American communities typically lack access within walking distance but have a higher concentration of smaller retails like convenience stores.
Gordon, 2011	Network Analysis	Measured access by store types (e.g., supermarkets, stores carrying healthy foods, fast food establishments) at block group level	Finding: African Americans had worse access to healthy foods, high income areas had better access to healthy foods but there was no statistically significant relationship between healthy establishment locations and income.
Wang, 2014	Network Analysis	Measured access from neighborhoods to supermarkets and farmers markets	Concluded that densely populated areas with poor access to supermarkets had improved access to fresh foods through the inclusion of farmers markets

Reference	GIS Analysis Type	Actions taken	Summary/Findings
Russell and Heidkamp, 2011	Network Analysis	Measured access as one-quarter, one-half, and one mile buffers around stores by store type	Buffers were created and then overlaid with socioeconomic characteristics and determined low access is correlated with: low income, high poverty, and limited transportation access.
Jiao, 2012	Network Analysis	Measured access as 10-minute walk (0.5 miles), 10-minute bike ride (2 miles), 0.25 to a transit stop, and one mile along a road network to create service areas from stores	Created service areas created for each store by: 1) identify furthest point reachable at each measure, 2) connect points to create a polygon/service area. Overlaid service areas with census block group income data; found that areas with low access are typically low income.
Larsen et al., 2008	Network Analysis	Measured Access as determined by shortest path from census block centroids to supermarkets using series of measures	Measures used: 1) 500-meter distances between residences and transit stops, 2) 10-minute bus ride from transit stops to supermarkets, 3) 100 and 500-meter walking distances from residences to supermarkets Finding: communities with a low socioeconomic status have less physical access to supermarkets
Apparacio et al., 2007	Network Analysis	Measured access at block group level regarding density (1-km buffer around block) of food establishments, and distance from block centroid to nearest 3 food establishments	Overlaid physical access with socioeconomic data Concluded that food deserts have more single parent households, higher unemployment, low education attainment, and more immigrants
Pearce et al., 2007	Network Analysis	Measured distances from census meshblock (i.e., New Zealand's measure like US census block) to nearest fast food establishment	Characterized neighborhood by type (e.g., urban, rural) and socioeconomics (e.g., income). Found areas with lower socioeconomic status were closer to fast food establishments versus supermarkets
Pearce et al., 2006	Network Analysis	Measured distance from resources for a healthy lifestyle (e.g., healthy food) to meshblock centroids	Found that food deserts have physical and socioeconomic components and are typically located in low-income neighborhoods.

Reference	GIS Analysis Type	Actions taken	Summary/Findings
Leete et al., 2012	Network Analysis	Combined proximity measures from census block and track centroids, density of store locations, and concentration of poverty to determine access	Access measured: 1) number of establishments within 1 kilometer of the centroid, 2) mean, median, minimum, and maximum distances to nearest three supermarkets Characteristics: high poverty, low education attainment, more immigrants, higher unemployment, more single parent household, and less automobile access.
Sadler et al., 2011	Network Analysis	Measured access between establishments (e.g., grocery stores, supermarkets, or fast food retailers) and residences	Generated distance scores for residences, aggregated to block groups to create a distress index using: education attainment, unemployment rate, lone parent households, low income, and low transportation access. The concluded: socioeconomically distressed areas traveled shorter distances to retailers.
LeClair and Aksan, 2014	Network Analysis	Generated a time cost by multiplying distances from households to supermarkets by minimum wage	Time cost was created to demonstrate that greater distances imply greater costs for consumers. They found that communities with poor access were: low income, retired households, ethnic minorities, had low education attainment, and had higher levels of poverty.
Coveney and O'Dwyer, 2009	Network Analysis	Measured access as distances between residences and chain supermarkets	If residences were further than 2.5 kilometers from the nearest supermarket, and lacked a vehicle, they had poor access. Rural and indigenous communities tended to have less access
Eckert and Shetty, 2011	Network Analysis	Measured distances from grocery stores carrying fresh food to residences	Data was generated by household then aggregated to block level to be overlaid with socioeconomic data. Those living in block groups with compromised access traveled further than a mile to the nearest supermarket, lacked a vehicle, were more likely to use public assistance, and were low income.

Reference	GIS Analysis Type	Actions taken	Summary/Findings
Pearson, 2005	Network Analysis	Created questionnaires which were organized by postal codes and derived distances from homes to supermarkets	Questionnaires included information about demographics, transportation, and food purchases, then GIS was used to determine distances from households to supermarkets. Cultural factors like age (e.g., older) and gender (e.g., female) had a greater impact on food decisions than material factors
McEntee and Agyeman, 2010	Network Analysis	Determined distances between supermarkets to rural residential units	After measures were generated at household level, data was aggregated to census tract level and areas that greater than 10 miles from establishments were considered food deserts. These communities were typically poor, with high poverty, more ethnic minorities, and more chronic health issues
Breyer and Voss-Andreae, 2013	Network Analysis	Provided a comprehensive view of community food environments with proximity, density, and quality of food measures	Categorized stores by whether they provide produce items to model purchasing by health conscious but price sensitive shoppers. Determined that access was best at the city center and worse along the periphery, but most low-cost stores were outside of the city center

The variables noted in Tables 1 and 2 were useful in determining which variables to use in this research, and refining the methodology. All variables noted in the tables were used, and weights were generated by using the number articles that mentioned the variable, and are summarized in Table 3 in the following chapter. Income was the most heavily mentioned variable, as 20 articles noted income either as a factor in determining food deserts, or as a characteristic of an area deemed to be a food desert. Race was the second most heavily mentioned variable, with 15 articles noting the significance of race (within communities) as a determinant, or characteristic of food deserts. The method of weighted variables according the number of articles that mention that variable was used in Bell et al., (2007).

The literature also assisted in determining how to utilize GIS to model food deserts. As displayed in Table 2, researchers most frequently used network analyses to determine access, namely between communities and or residents and food establishments, therefore, the same technique was used in this research. Most researchers that used socioeconomic variables focused on overlaying the data at the community level (e.g., Census Block Groups), which was used in this research as well.

CHAPTER 3. METHODOLOGY

The purpose of this study is to test a mapping exercise that consider the influence of distance, food costs, and socioeconomic vulnerability to determine which areas on Oahu have the least access to healthy food in supermarkets. The study completes three steps (summarized in Figure 1): data pre-processing, development, and overlay. Data pre-processing prepared data to be utilized in ArcGIS by identifying supermarkets and residences, creating the network dataset to determine distances between households and supermarkets, and generating socioeconomic data used in the overlay. This step answered part of the first question regarding where households and supermarkets are located on Oahu.

The cost distance was the product of the data development phase, completed by creating a market basket with prices at each store, determining distances between residences and supermarkets, and compiling the two. The market basket was created using literature and the USDA TFP to generate a list of foods to obtain prices at each supermarket, answering what the cost of a basket of goods at each supermarket was. Distances between residences and supermarkets were generated using the Network Analysis function in ArcGIS then combined with prices to generate cost distances. This answered what the distances between residences and supermarkets are, and which areas lack access as a function of proximity and costs.

The Overlay function in ArcGIS was used to overlay socioeconomic variables, demonstrating which areas are most socioeconomically vulnerable, and with cost distances to model which areas have the least access to supermarkets on Oahu. Three different measures were utilized: 1) weighing socioeconomic vulnerability and cost distance equally, 2) weighing socioeconomic vulnerability three times as heavily, 3) weighing cost distance three times as heavily. The result is three models of how physical distances, costs, and socioeconomic vulnerability can shift access to healthy foods in supermarkets. Maps are found in Appendix C.

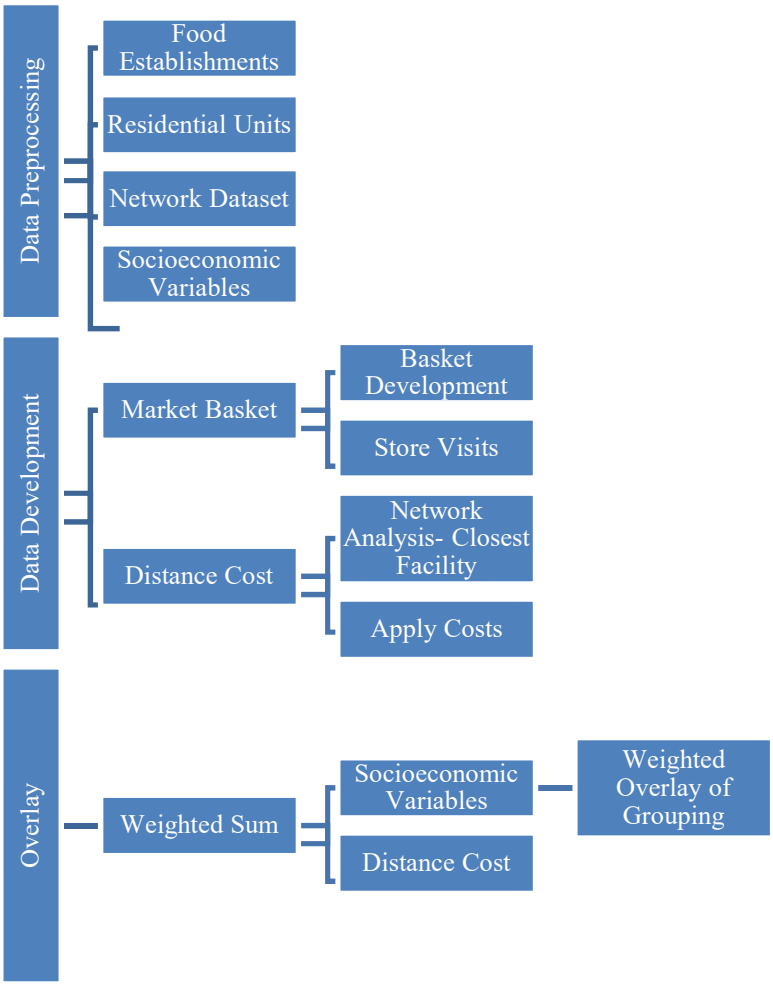


Figure 1. Methodology Summary.

3.1. Data Pre-Processing

Data pre-processing transferred raw data into formats utilized in GIS to determine locations of supermarkets and residential units, and created the network dataset to measure distances. All geographic place names are displayed in Map 2 titled *Geographic Place Names*.

3.1.1. Food Establishments

An excel file was obtained from the Hawaii Department of Health with every food establishment, permit number, full address (street number, name, and zip code), mailing address, TMK data, and establishment type inspected as of February 2015. Internet searches determined no new supermarkets emerged, or went out of business, between the time the list

was compiled and analysis was completed. Each establishment was Geocoded using ArcGIS and City and County of Honolulu Street Centerline data, which contains street directions enabling the utilization of a Dual Range Address locator that uses street directions to determine locations along a street. Addresses not geocoded through ArcGIS were manually geocoded using Google Earth to generate geographic coordinates. A total of 76 food supermarkets were located and grouped into 16 franchises displayed in Map 3 titled *Store Locations*. All Stores are listed in Table 8 of Appendix A, and the stores visited are listed in Table 9.

3.1.2. Residential Units

A total of 142,821 Tax Map Parcel Keys (TMKs) represented households in this research. The Honolulu County Planning and Permitting Department provides a polygon shapefile containing the location of TMKs and a database with the number of living units. The database was joined to the polygon to determine which have inhabitants, and then converted to points which enabled distance measures to food establishments in the Network Analysis. TMKs were intersected with Census Block Groups and outliers were removed by locating TMKs outside of data clusters using the Oahu TMK listing; if no living units were located on property, the data point was eliminated. Points located in Census Block Groups without population data were also eliminated. The results are displayed in Map 4 titled *Residential Units* and utilized in the network analyses as incidents. The data does not account for illegal dwellings, homeless, squatters, and unoccupied homes.

3.1.3. Network Dataset

Network datasets model transportation networks, including features like lines, points, turns and their restrictions, and source feature connectivity. Polyline data is converted into formats utilized in the Network Analysis extension of ArcGIS where directions along roads are determined, and characteristics like one-way streets, connectivity, and turns enable processing

consistent with transportation. The result is a network of nodes indicating street ends, and streets defining network connections.

Street centerline data was downloaded from the City and County of Honolulu Planning and Permitting Department then uploaded to the Network Analysis extension as the network dataset. The threshold for the network analysis was set as a maximum of 50 miles. A total of 26,841 street centerlines from the City and County of Honolulu were converted into a road network used in the network analysis generating a total of 21,523 nodes indicating intersections and street endings. The results are displayed in Map 5 titled *Road Network*.

3.1.4. Socioeconomic Variables

Socioeconomic data was generated to identify areas with distress, determined through variables in the literature. This research uses an approach similar to Bell et al. (2007) which created a socioeconomic deprivation index by weighing variables based on the number of times the variable was mentioned in the literature. Weights given in this research were based upon the number of times mentioned in the literature reviewed. The purpose of this was to display the socioeconomic status of census block groups utilizing variables mentioned in the literature, while emphasizing the variables that were frequently mentioned.

The rankings within each variable ranged from 1 to 5. Rankings of "1" indicated areas with a high socioeconomic status, while rankings of "5" indicated the most vulnerable areas. The rankings were generated by dividing the data into intervals, unless otherwise noted. In instances where the minimum is zero percent and the maximum was 100 percent, the extreme values are represented in the rankings "1" or "5." The intermediate rankings of "2" to "4" are generated by dividing the remaining data into three classes/intervals. If only one extreme is present, the other four classes are generated by subtracting the maximum from the minimum and dividing the remaining data into 4 classes/intervals.

Data was obtained from the US Census Bureau American Fact Finder American Community Survey 2014 (Census), the Hawaii State Department of Education (D.O.E) School Lunch Data, and the Hawaii State Department of Health (D.O.H.) State of Hawaii Primary Care Needs Assessment Data Book 2012. Processing was completed by: 1) downloading or generating data in tabular form, 2) downloading complementary shapefiles, 3) intersecting tabular and shapefile data, 4) generating shapefiles with socioeconomic data and weights attached, and 5) converting shapefiles into raster format. The process is summarized in Figure 2 and all variables are summarized in Table 3.

Geographic identifiers (GEOIDs), or twelve digit numeric codes used by the Census Bureau to uniquely identify areas by state, county, tract, and block group, were used to join tabular and shapefile data for block groups. After GEOID's and rankings in tabular data were created, tabular and shapefile data were connected using the join function. All unpopulated block groups, and those with missing income or more than half the socioeconomic variables, were not used in the analysis. The final shapefiles contained tabular data with ranks and were converted to rasters. Oahu contains a total of 591 Census Block Groups, twelve had no residences and seven lacked adequate socioeconomic data and were removed for this research. The Census data file titled "Total Population" identifies the number of people within a census block group and was used to identify the areas with no people and take out unpopulated block groups. A total of 572 Census block groups were used in the analysis and are displayed in Map 6 titled *Census Block Groups*.

3.1.4.1. Hawaii State Data

School lunch data was generated from Department of Education data, and joined to the high school district shapefile from DBEDT. Tabular data was edited to generate the percent of

students eligible to receive free or reduced price school lunch by area, joined to the school district shapefile, then converted into raster format.

Health data was generated from the State of Hawaii Primary Care Needs Assessment Data Book 2012 for obesity, diabetes, high blood pressure, disease of the heart mortality, cancer mortality, and stroke mortality rates. The Department of Health divides the data by county and individual communities which utilize Census tracts as boundaries. The tabular health data was joined to the tract shapefile.

3.1.4.2. Census Data

Eighteen variables were compiled and separated into ten groups, divided by topic, summarized in Table 3. Sixteen variables were generated from Census data. The weights assigned to each category sum to one-hundred percent, and the weights within each category sum to one-hundred percent.

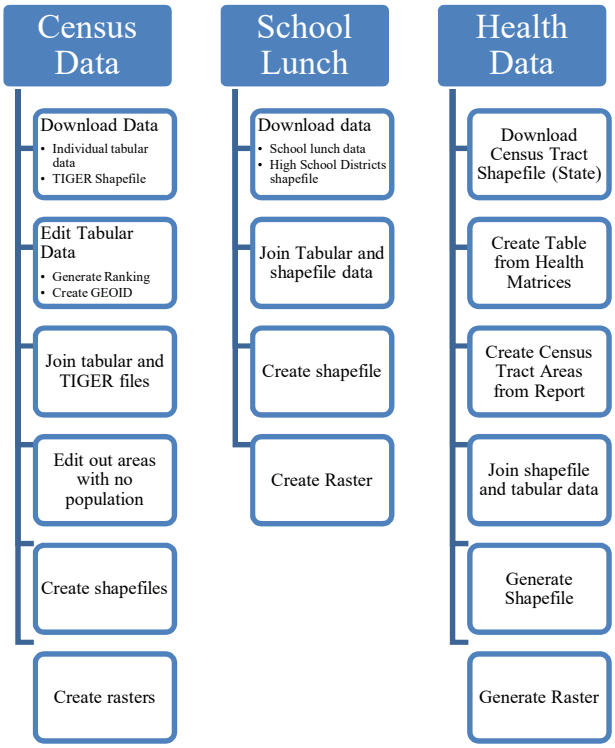


Figure 2. Variable Summary.

Table 3. Summary of Variables. The column points indicate the number of reviewed literature sources that mention that specific variable as contributing to a food desert; measures with no value were not directly mentioned by the literature (e.g., per capita and median household income) Major categories are indicated by bold.

Category	Variable	Source	Unit of Analysis	Points	Weight	Ranges	Min	Max	Average
Income	**Weighted per capita and median income**			20	**0.2197**				
Income	Per capita income	Census	Block Groups		0.5	1) >400% above poverty level (>$54680) 2) <= 400% above poverty level ($34175-54680) 3) <=250% above poverty level ($20505-34175) 4) <= 150% above poverty level ($13670-20505) 5) At or below poverty level (<$13670)	$4259	$83116	$31842
Income	Median Income	Census	Block Groups		0.5	1) Greater than twice the state average (>$106964) 2) Between county average and twice state average ($73581- 106964) 3) Between state and county average ($53482-73581) 4) Between half state and county average ($26840 -53482) 5) Less than half the state average (>$26840)	$13365	$176250	$78792
Poverty	**Poverty**	Census	Block Groups	9	**0.0989**	1) No households live below the poverty line 2) 0-10% live below the poverty line 3) 10-20% live below the poverty line 4) 20-40% live below the poverty line 5) >40% live above the poverty line	0%	58.23%	6.79%
Employment	**Unemployment and Underemployment**			4	**0.0440**				

	Employment	Unemployment	Census	Block Groups		0.5	1) No unemployed residents 2) >0-16% unemployed residents 3) 16-33% unemployed residents 4) 33-50% unemployed residents 5) >50% unemployed residents	0%	65.19%	7.01%
	Employment	Underemployment	Census	Block Groups		0.5	1) No residents considered underemployed 2) Weight = 0-18 3) 18-36 4) 36-54 5) 54+	Weight =0	Weight= 75	Weight= 17.96
	Race (Native Hawaiian/Pacific Islander [NHPI))	**Percentage of Native Hawaiian/Pacific Islander**	Census		15	**0.1648**	1) No residents identify as NHPI 2) <0-15% residents identify as NHPI 3) 16-33% residents identify as NHPI 4) 33-50% residents identify as NHPI 5) >50% residents identify as NHPI	0%	100%	9.16%
	Automobile Access	**Percentage of automobile access**	Census	Block Groups	12	**0.1319**	1) All residents have a vehicle 2) <100-84% of residents have a vehicle 3) 83-67% of residents have a vehicle 4) 66-50% of residents have a vehicle 5) >50% of residents have a vehicle	35.36%	100%	90.21%
	Education Attainment	**Education attainment weight**	Census	Block Groups	7	**0.769**	1) Weight = less than 1 2) 1-2.5 3) 2.5-4 4) 4-5.5 5) Greater than 5.5	Weight= 0.004	Weight= 5.7	Weight= 1.66
	Age	**Elderly/Young Weight**	Census	Block Group	8	**0.879**	1) Weight = 0 (No residents >18 or >65 years) 2) Weight = 0-11 3) 11-22 4) 22-33 5) 33+	Weight= 0	Weight= 45.31	Weight= 24.51
	Family Dynamics	**Household size, immigrants, single parent**			9	**0.0989**				

Family Dynamics	Number of People in household	Census	Block Groups	1	0.1111	1) No households have > 7 inhabitants 2) <0-14% households have > 7 inhabitants 3) 14-28% 4) 24-42% 5) >42%	0%	56.36%	9.03%
Family Dynamics	Immigrants	Census	Block Groups	2	0.2222	1) >0-16% have an immigrant in the household 2) 16-33% 3) 33-50% 4) 50-66% 5) >66%+	0%	100%	19.64%
Family Dynamics	Single Parent Household	Census	Block Groups	6	0.6667	1) No single parent households 2) Weight = >0-40 3) >40-80 4) >80-120 5) >120	Weight= 0	Weight= 166.08	Weight= 56.82
Community Wealth	**Home value and owner, assistance, tenure, lunch**			5	0.0549				
Community Wealth	Home value	Census	Block Groups	1	0.2	1) Greater than $1M median home value 2) $750-999K 3) $500-750K 4) $250K-500K 5) Less than $250K	$114000	>$1M	** (footnote: no values greater than 1M)
Community Wealth	Public Assistance	Census	Block Groups	1	0.2	1) No households received public assistance 2) >0-8% of households 3) 8-16% 4) 16-24% 5) 24%+	0%	33.78%	3.56%
Community Wealth	Tenure	Census	Block Groups	1	0.2	1) No tenants moved in after 2010 2) 0-33% tenants moved in after 2010 3) 33-66% 4) 66-100 5) 100%	0%	100%	42.91%
Community Wealth	Home Owner	Census	Block Groups	1	0.2	1) All units were owner occupied 2) 99-66% of the units' owner occupied 3) 66-33% 4) 33-1% 5) No units were owner occupied	0%	100%	56.72%

Community Wealth	School lunch	D.O.E.	High School Districts	1	0.2	1) >16% of students eligible for free/reduced lunch 2) 16-33% 3) 33-50% 4) 50-66% 5) Greater than 66%	14.77%	80.38%	47.55%
Health	**Chronic health, disabled**			2	0.220				
Health	Chronic Health	D.O.H.	Census Tracts	1	0.5	1) No health measures above average 2) 1 or 2 measures above average 3) 3 measures above average 4) 4 or 5 measures above average 5) All measures above average	0 measures	6 measures	2.74 measures
Health	Disabled	Census	Block Groups	1	0.5	1) No households with a person with a disability 2) 0-25% households with a person with a disability 3) 25-50% 4) 50-75% 5) 75%	0%	100%	25.03%

Variables regarding the economic status of households include income (e.g., per capita and median household income) and employment status (e.g., unemployment and underemployment). Income Data was generated using per-capita and median income figures weighed equally in an overlay. Most of Oahu is in the high/mid-high income range mirroring State and County averages for per-capita and median household income. When accounting for households living below the poverty line, based on measures from the Food Environment Atlas threshold of twenty percent of households living in poverty, it was determined that most of Oahu is not living in poverty. There were no outliers with ranks of 1 or 5 regarding employment, so it is assumed that there are no areas where everyone is employed, unemployed, or underemployed. Also, car access is widespread on Oahu and areas where less than half of all residents have car access (e.g., Kaimuki to Kalihi) could be due financial concerns or lack of necessity due to the proximity of resources and public transportation.

Hawaii Health Matters, which provides state and county level data on health and quality of life based on data provided by the State of Hawaii, identifies Hawaiians/Pacific Islanders as having impediments regarding food access. The highest concentration of Native Hawaiians/Pacific islanders are within Nanakuli and Waianae. Kahuku to Kahaluu, Waimanalo, Kapolei, west Oahu from Kapolei to Waianae, Waipahu, Kalihi, and urban Honolulu, as displayed in Map 7 titled *Prevalence of Pacific Islanders and Native Hawaiians*.

Education attainment weights were generated using the ratio of people who obtained specific levels of education where a larger ratio indicates that fewer residents have high education attainment (e.g., college degrees) and most of Oahu is not considered to be vulnerable.

For age, the weights generated emphasized the number of elderly and the number of those who are minors, and much of the island had a high weight indicating greater vulnerability.

Despite the weights generated, the variable was not deemed useful because most of the island still has significant transportation access, and it is assumed that minors live with a parent or guardian who would be able to obtain access.

This research analyzes several other variables that have been identified as influencing food accessibility in the literature, but found them to yield undistinguished pattern on Oahu. For example, the variable Family Dynamics by overlaying data identifying households with many people (i.e., greater than 7 inhabitants), those with immigrants, with single parents, with an unemployed parent, especially single mother households as emphasized in the literature.

This research also analyzes community wealth when incorporating homeownership, median home value, public assistance and free and reduced price lunch eligibility. Rankings were skewed due to the prevalence of military bases, where home values and homeownership are non-existent (i.e., Marine Corp Base Hawaii Kaneohe, Schofield Barracks, Hickam Air Force Base, Camp H M Smith, Pearl Harbor, Kalaeloa, and Fort Shafter). When excluding bases, most of the island is in the mid to mid-high range of homeownership, and median home values.

Data regarding Free and Reduced Price School Lunches in Hawaii Public High Schools is provided by the Hawaii State Department of Education. The percentage of students eligible for the program was compiled by high school jurisdiction and areas with the highest concentration of students eligible for the program are in Nanakuli, Waianae, and the urban core (McKinley to Farrington). Areas with a mid-high concentration are in Kaimuki, Kailua, Waipahu, Wahiawa through Kaaawa (Leilehua, Waialaua, and Kahuku school districts. The results are displayed in Map 8 titled *Free and Reduced Price Lunch Eligibility*.

The Hawaii State Department of Health Family Health Services Division published health data by area in their report *State of Hawaii Primary Care Needs Assessment Data Book*

2012. Six measures were used from this report, all of which can be aggravated or caused by a poor diet including: the percentage residents with obesity, diabetes, high blood pressure, and the mortality rate of diseases of the heart, cancer, and stroke. The average for each health measure was calculated then each area was identified by the number of health measures above average. Kalihi, Waipahu, north and northwest Oahu from Nanakuli through Waialua, and all northeast Oahu had above average prevalence of health issues. Wahiawa was the only area with all health measures above average. The results are displayed in Map 9 titled *Prevalence of Chronic Health Issues*.

Eighteen variables were used in the model, but only five stood out as useful for Oahu, and were mapped: the prevalence of Native Hawaiian and Pacific Islanders, free and reduced price lunch eligibility, and chronic health issues. Mapping exercises were completed for all socioeconomic variables but the lack of significant patterns for most variables proved that the inclusion of the maps to be unnecessary.

3.2. Data Development - Creating the Market Basket and Visiting Stores

A market basket was used to establish food costs on Oahu within individual supermarkets. Market Basket literature and documentation provided by the USDA was used to generate a list of food products to take to supermarkets and gather prices.

3.2.1. Creating the Market Basket

The USDA provides consumption patterns of males and females within each age group given by the average number of pounds consumed by each age group broken down into specific food items organized by food groups such as grains, vegetables, fruits, milk products, meats and beans, and other foods. The USDA categorizes food groups and provides examples of products within each group. Selection of food products for this research was similar to Beyer and Voss-

Andreae (2013) which focused items likely to be consumed by health and price conscious consumers. Blank sheets listing the products priced in this research are in Appendix B, Tables 9 through 13.

Products were divided by categories, and the lowest cost per unit product was selected. The category "other foods" is comprised of items like condiments, tea, and coffee and were excluded in this analysis as they are complementary products in a balanced diet.

Grains consist of whole and non-whole grain breads, rice, pasta, and pastries, whole grain cereals, popcorn and snacks; both whole grain and non-whole grain products were used in the basket compilation. Rice, pasta, and bread were selected due to their versatility and the ability to purchase in bulk. Ready to eat cereal was used as minimal preparation is needed; for whole grain items, low-sugar products were used. For hot cereal, oatmeal was used for whole-grain variety and grits were used for non-whole grain variety as they were the most widely available. Finally, tortillas were used as an alternative to bread.

The vegetable group consists of: potato products, dark green vegetables, orange vegetables, canned/dried beans, lentils, and peas, other vegetables. Stores provide vegetables in a variety of ways including fresh, frozen, and canned but only fresh and frozen were used as canned vegetables have added salts; items were selected based on the lowest price per unit. Only whole potato products were used for the following potato types: russet potatoes (often the cheapest potato and can be purchased in bulk), Asian potatoes (not provided by the USDA, but included due to availability), and red/ yellow potatoes (not provided by the USDA, but included to increase the variety). For dark green vegetables kale, spinach, and broccoli were used to provide a combination of leafy and cruciferous vegetables. Carrots, sweet potatoes, pumpkin were used for orange vegetables and selected as they are widely available. The USDA provides a

list of "other" vegetables that were difficult to organize. The items used in this research include: Tomatoes, corn, onions, peas, green beans, celery, cucumber, zucchini, mixed vegetables, cauliflower, mushrooms, bell peppers.

Fruits consist of whole fruits and juices. The emphasis on fruit selection was raw or frozen fruits, as canned versions tend to be stored in syrups. One selection of the lowest price melon item was provided in addition to oranges, lemons, limes, and grapefruits. For berries, strawberries were the most widely available and affordable choice. Bananas and apples were used as they are widely available, can be purchased in bulk, require minimal preparation, and can be easily transported. Grapes were used as they are common in stores and require minimal preparation. Papaya and pineapple were used because they are commonly available and locally produced. For fruit juices, non-refrigerated products were used for apple and grapefruit juice.

The milk group consists of: whole and low fat milk, yogurt, and cream; cheese; milk drinks and deserts. The USDA noted that dairy consumption is not prominent, therefore, few products were used. For this research, a whole and lower fat milk and yogurt product was used, as well as cheese product (lower fat products were used when available)

The meat and beans group consists of: beef, pork, veal, lamb, chicken, turkey, game meats and birds, fish, bacon, sausages, luncheon meats, nut, nut butters, seeds, eggs, and egg mixtures. The focus was on higher protein items like meats, beans, meat alternatives, and nuts/seeds. Fresh and frozen varieties were analyzed when available. For the bacon, sausages, and luncheon meats only one selection of a leaner cut such as turkey was used as they are often highly-processed convenience foods.

For the beef, pork, veal, lamb and game subgroup, beef and pork were more widely available and therefore used in this analysis. Ground beef was used for beef products and the

lowest fat content ground beef product was used. For pork, pork loin was often the cheapest and leanest cut of pork available.

In the chicken, turkey, poultry subgroup, chicken and turkey were the most widely available poultry food products, in both fresh and frozen varieties. Boneless, skinless chicken breasts were used as they are the leanest cut of chicken, most widely available in both fresh and frozen. For turkey, lean ground turkey or another turkey alternative was used such as turkey tenderloin.

For fish and fish products, a variety of products are available in fresh and frozen varieties. No sub-category types are provided by the USDA, but canned tuna was Selected because of its versatility and cost effectiveness (only varieties packed in water, versus oil, were used), while a shellfish, white fish, tuna, and salmon selection were also provided when available.

Several meat-less options were provided in this analysis, including beans, tofu, and nut butters. For beans, lentils, and peas, dried versions were selected due to cost effectiveness, but if dried was unavailable, canned varieties were provided. Tofu and meat alternatives were not included in any USDA meal plan, but were used to serve as a meat alternative. One tofu product and one other meat alternative product (such as veggie burgers) were provided when available. One selection a nut butter with minimal added salts, and sugars were selected. Finally, both eggs and egg substitutes were provided in this analysis

3.2.2. Store Visits

An excel spreadsheet was created with a list of the products and sections to fill out prices (Appendix B). The list of establishments was shortened to a list of franchises and only one store from each franchise (e.g., Safeway) was visited, as prices and products are similar in each

location (Appendix B). A partner (i.e., friends and family) was coached on how to select products and note prices. Qualitative notes were generated and summarized after each visit to note differences in product availability not reflected in the quantitative survey. Table 4 summarizes the franchises with the number of stores on Oahu and areas in where they are located. Appendix B provides a list of all stores generated in the data pre-processing.

Table 4. Stores by Franchise and location. ***Bold*** indicates the store visited for data.

Franchise	**Number of Stores**	**Locations**
Foodland [Sack n Save]	17	Honolulu (5), Kaneohe, Wahiawa, Ewa Beach, **Mililani**, Haleiwa, **Waipahu**, Laie, Pearl City, Kapolei, Kailua, [Nanakuli], [Honolulu]
Times/[Shima's]	15	**Mililani**, Pearl City, Waipahu, Kailua. Kaneohe (2), Aiea, Waipahu, Honolulu (6), [Waimanalo]
Safeway	14	Honolulu (6), Ewa Beach, Kapolei, Kailua (3), Kaneohe, **Mililani**, Aiea
Costco	4	Honolulu (2), Kapolei, **Waipahu**
Down to Earth	4	**Kapole**i, Honolulu, Aiea, Kailua
Tamura's	4	Hauula, **Kapolei/Kalaeloa**, Wahiawa, Waianae
Don Quijote	3	Pearl City, Honolulu, **Waipahu**
Palama Market	3	**Honolulu** (2), Aiea
Food Pantry	2	**Honolulu**
Marukai	2	**Honolulu**
Nijiya	2	**Honolulu**
Sam's Club	2	Honolulu, **Pearl City**
Whole Foods Market	2	**Honolulu**, Kailua
Kokua Market	1	**Honolulu**
Pacific Supermarket	1	**Waipahu**
Seafood City	1	**Waipahu**

The franchises with the most locations include Foodland, Times, and Safeway. Foodland is a Hawaii-based supermarket, also known as Sack-n-Save, with17 locations on Oahu. Foodland is limited in bagged produce items, and generic products, but a variety of Asian and Latino products is available and origins of some products, like locally grown produce meat products are

labelled. The initial location visited was Foodland Waipio, the second location visited to finalize the pricing of certain products was in Mililani Shopping Center. Times is a Hawaii-based supermarket chain with 15 locations, and is known as Shima's in Waimanalo. The store has a wide variety of ethnic foods (i.e., Asian and Latino products) but is not as extensive as Safeway regarding generic and brand products and bagged produce. The Times visited for pricing information in in Mililani Town Center. Safeway is a chain supermarket throughout the U.S wit 14 locations on Oahu, and has a variety of brand and generic products and produce, but is limited in ethnic foods. The Safeway visited for pricing information is in Mililani Marketplace.

Costco and Sam's Club are a national wholesale retailers where customers pay a yearly fee to obtain products in bulk at a discounted rate. While unit costs are lower, and they accept food stamp benefits, the disadvantages of wholesale retailers include: 1) limited locations, 2) upfront membership costs, and 3) having to purchase in bulk. Costco contains 4 stores and pricing information was obtained in the Waipio store. Sam's Club contains 2 stores and pricing information was obtained in the Pearl City store.

Down to Earth is a Hawaii-based vegetarian supermarket (i.e., no meat or egg products were available) with 4 locations and has a variety of bulk foods and natural healthcare/beauty products. This was one of the few locations where staff asked what myself and my partner were doing then assisted in locating products. The location visited for pricing was in Kapolei.

Oahu has a handful of stores focused on providing Asian products including: Seafood City, Pacific Supermarket, Don Quijote, Palama Supermarket, Nijiya Market, and Marukai Marketplace. Seafood City is a Filipino supermarket chain on the western US and Waipahu, Hawaii. There was a variety of fish and produce with products uncommon in supermarkets such as taro. Like other Asian markets, there were limitations in obtaining prices for products not

usually consumed by the Asian population such as milk. Pacific Supermarket primarily Filipino supermarket in Waipahu. Like Seafood City, many products were limited as they are not generally consumed by the Asian populace and the produce department had products not normally available in supermarkets. Don Quijote is an Oahu-based chain with three Oahu stores with an overwhelming variety of ethnic (i.e., Asian and Latino) products. This was one of the longest store visits because of the size of the store and offering products varying from food to beauty products to household goods. The store visited for pricing is in Waipahu. Palama Supermarket is a supermarket providing Korean products in three Oahu locations. Like other Asian food stores, some products were limited (e.g., milk) but there was a plethora of products Asian/Korean food. The location visited for this analysis is in Downtown Honolulu. Nijiya Market is a Japanese Grocery store located in Hawaii, California, and New York, with two Oahu locations. Nijiya had the most incomplete basket for this analysis due to the small store size, and lack food products. There was a variety of high end, gourmet and Japanese food products. The location visited is located on University Avenue. Marukai Wholesale Mart operates similarly to Costco and Sam's Club where consumers purchase a membership to receive reduced prices. Unlike other Asian food stores, Marukai had a wider variety of American food products like milk, and like Don Quijote, can be considered a one-stop-shop with a variety of beauty and household products available as well. As it is a Japanese food store, there was a wider variety of exotic fish products and Japanese snacks. The location visited for this research is located on Auahi Street near Ward Warehouse.

Kokua Market is a co-op in Honolulu near the University of Hawaii at Manoa. The purpose of a co-op is to encourage business investments to operate and maintain its business expenses. Most produce and meat products are local and sustainable (e.g., line caught fish). The

store also sells bulk food items such as oats and popcorn. This was another store where the staff asked if I was pricing items and aided after I explained the project

The Food Pantry provides grocery service for tourists and residents in Waikiki. Despite its location, products were cheaper than expected. It is a comparable size, and provides a similar number of products, as any other local/national chain supermarket visited. There are two locations within Waikiki and the location visited for pricing is located on Kuhio Avenue.

Tamura's is a locally based grocery store on Oahu and Maui, with four grocery on Oahu. Tamura's also has liquor stores, which were not utilized in this analysis. Tamura's is a fixture in the communities where it is located as it donates money to local public schools. The variety and amount of produce was limited, but was satisfactory quality and appeared fresh. Product availability was like Times and Foodland regarding brand and generic varieties, but had a variety of Asian and Latino products. The location visited for food pricing is in Kalaeloa.

WholeFoods is a natural and organic food store that prides itself on having a variety of organic produce, meats, and bulk food items. With a variety of premium products also comes a higher price with many the products being the costliest for a large, national food chain in this analysis. WholeFoods has two Oahu locations, the store visited is in Kahala Mall.

3.2.3. Basket Costs

The data was collected into an excel spreadsheet for each store (Appendix B) for a total of 16 market baskets (summarized in Tables 14 through 29). The cheapest product for each food was selected, as determined by the price per unit (e.g., if fresh broccoli was $2.46/pound, but frozen broccoli was $2.00/pound, the frozen broccoli was used). Judgment was used to standardize units when unavailable (e.g., bunches of spinach were assumed to be 1 pound) which may skew products, but was uncommon.

The USDA provides the average amount of food that males and females consume by age and product. To provide a basket, the consumption of a family of four (Male and Female 19-45, one child in the 2-3 and 9-11 age groups), was used. The amount consumed individually was combined to generate consumption patterns by food groups, to generate the amount an average family of four consumed in a week; this is summarized in Appendix B, Table 30. This measure was multiplied by the lowest price for each product to generate a market basket price. This market basket is used later in the cost distance analysis.

If products were completely unavailable, for example Down to Earth sells no meat products, then prices were calculated as follows: price of product from the most expensive store selling the product multiplied by the amount consumed = value of product for that component in the basket. For example, Down to Earth does not sell chicken and Nijiya Market has the most expensive cut of chicken available at $12.99/pound, the total consumption of this product is six pounds, therefore, the market basket cost for chicken at Down to Earth is $77.94. This skews the analysis, particularly regarding animal products, dairy products, and nuts/nut butters. This method was utilized to give a value for each component in each basket to reflect the notion that if the product was not available at the store, the consumer would have to seek another store to purchase the item; the highest cost of the item was used to give a prohibitive cost. Future analyses could use the nearest store with that item rather than the most expensive item.

Appendix B displays the basket price across all store franchises, by food group and overall price, and Table 5 summarizes the range and average of each product basket and the overall market basket. For overall basket prices, wholesale retailers Costco and Sam's Club had the lowest overall costs. For supermarket type stores, Pacific Supermarket, Seafood City, and

Tamura's all had the lowest cost baskets. Down to Earth had the highest overall basket cost but was skewed by the fact that no animal products were available (summarized in Table 36).

There were differences between food groups in terms of which stores provided the cheapest options, these results are summarized in Appendix B Tables 31 through 35. For proteins, Costco had the overall cheapest prices, while Times was the cheapest among supermarket type stores, and Down to Earth had the most expensive basket. For grains, Sam's Club had the cheapest overall basket, Tamura's had the cheapest basket for supermarket type stores, and Kokua Market had the most expensive basket. For milk products, Costco and Sam's Club had the cheapest baskets and were nearly identical in price, for supermarket type stores Safeway, Pacific Supermarket, and Don Quijote had the cheapest baskets and were similar in price, in contrast, Palama Supermarket had the most expensive basket due to the lack of milk products available within its stores. For fruits, Sam's Club had the cheapest basket, Seafood City had the cheapest basket within supermarket type stores, while Kokua Market had the most expensive basket. Finally, for vegetables, Pacific Supermarket had the cheapest basket, while Kokua Market had the most expensive basket.

Table 5. Summary of the range and average market basket prices by product, prices are assumed to be the same in each store (e.g. Kailua and Mililani Safeway have the same prices).

Basket	**Range**				**Average Cost ($)**
	Low Range (Cost $)	Low Store	Upper Range (Cost $)	Upper Store	
Protein	45.56	Costco	195.60	Down to Earth	96.42
Grain	5.01	Sam's Club	26.39	Kokua Market	12.05
Milk	9.31	Costco and Sam's Club	41.32	Palama Supermarket	19.45
Fruit	18.64	Sam's Club	42.42	Kokua Market	31.93
Vegetable	27.86	Pacific Supermarket	77.67	Kokua Market	46.44
Overall	118.14	Costco	354.25	Down to Earth	206.99

3.3 Network Analysis

3.3.1 Closest Facility

The closest facility function of the Network Analysis extension in ArcGIS, was used to determine the facility nearest to the incidence (residences). The extension enables the user to identify the nearest facility defined by distance or time within a specify a cut-off distance (e.g., if a 0.25-mile limit is selected, no facilities beyond 0.25 miles will be searched) (ESRI Help, "Closest Facility Analysis"). For this analysis, distances are the "cost" determining which facility (stores) nearest to each residence A maximum distance of 50 miles was set.

3.3.2. Cost Distance

The method used in this research for incorporating food costs and distances between residences and supermarkets is based on Hallet and McDermott (2011). Their model developed a cost surface analysis utilizing food costs and distances to food establishments and identify underserved areas as areas where consumers spend ten percent or greater of their food budget on transportation to and from the grocery store. Researchers completed measures for walking and driving. For driving, the authors used the equation: Total cost of driving = (the US Internal Revenue Service cost of operating a motor vehicle multiplied by the miles to nearest full-service food outlet by road network). This cost was compared to the market basket cost, which was $55 weekly and based on how much the average consumer spends on food annually, a figure produced by the Bureau of Labor Statistics. The authors determined an underserved area as one that the consumer needs to spend more than $2.78 one way to travel to a store (Hallett and McDermott, 2011).

Vulnerable communities were identified as those spending more on transportation and food, measured as the cost to travel to a store and cost of a basket of goods, as a single measure.

The model used in this analysis is: cost distance = (network distance to nearest store * IRS cost of operating a vehicle ($0.54/mile)) + cost of basket of nearest store). These measures were calculated for each residence then aggregated to Census Block Group level by averaging the cost per residence: cost distance for Census Block Group = sum of cost distances of residences within block group/number of TMKs in a block group. The cost of the market basket has a larger impact on the cost distance than the distance between households and stores.

A total of 528 Census Block Groups contained cost distance data, with 44 Census Block groups not having a cost distance, which lacked data due to their presence on military bases or location in a non-traversable area. A total of 134,858 routes were generated from residences to closest food stores and the average distance between households and the nearest supermarket is 1.23 miles for Oahu, with a range of 0.03 to 12.35 miles. Rankings were determined using natural breaks/Jenks, which divide data into clusters maximizing the classes average deviation from the mean, in comparison to the derivation between other clusters as well. The average cost distance for Oahu is $184.39, which is within the middle ranking. This yielded five groups with rankings:

1. $118 - $145.701461
2. $145.701462 - $175.714286
3. $175.714287 - $207.379391
4. $207.379392 - $276.614173
5. $276.614174 - $355

Areas with the lowest cost distance were within Mililani, parts of east Honolulu, Waipahu, and Pearl City. Most of the island had a cost distance within the mid to mid-low rank, as demonstrated in Figure 3 and displayed in Map 10 titled *Cost Distance*. Areas with the highest cost distance were in Kailua, and the urban core near the University of Hawaii at Manoa and Kaimuki. High cost-distances are attributed to the emphasis of the cost of the market basket,

which makes up most of the cost in the cost distance, rather than the distance between households and stores which cost is only $0.54 per mile travelled.

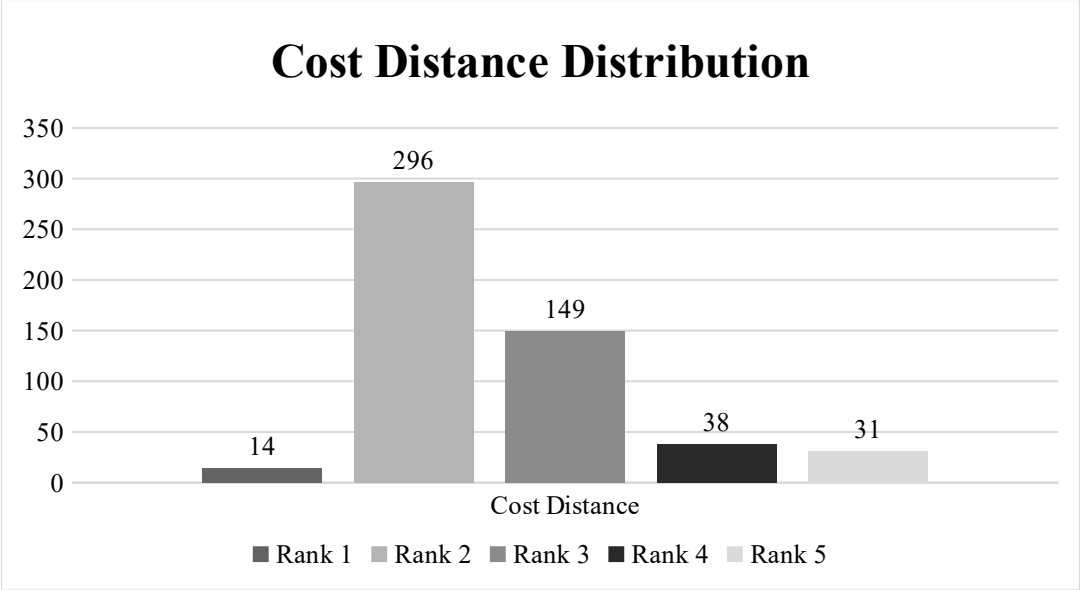


Figure 3. The distribution of cost distance ranking.

3.4. Data Overlay and Determining Food Deserts

In the analysis, socioeconomic variables were overlaid using weighted overlay to classify the data from (1) least to (5) most vulnerable, providing extremes, a midpoint, and gradients where: "1" represents least impoverished areas indicating the wealthiest block groups, and "5" represents the poorest households. The weighted sum function was used to combine the socioeconomic data with reclassified cost distance data to generate the final overlays that incorporated distance, cost, and socioeconomics.

Three weighted sums generated areas that could be deemed food deserts as a function of cost distances and socioeconomic vulnerability. The first weighted sum valued cost distance and socioeconomic vulnerability equally (i.e., weight= 0.5) (Map 12). The second emphasized cost distance more heavily (i.e., weight = 0.25 socioeconomic vulnerability and 0.75 for cost distance) corresponding to literature identifying food deserts as primarily a function of physical

access (Map 13). The final analysis weighted socioeconomic vulnerability more heavily (i.e., weight=0.25 for cost distance 0.75 for socioeconomic vulnerability), placing more emphasis on areas with a low socioeconomic status even if physical access is not an issue (Map 14).

CHAPTER 4. RESULTS

The modelling exercise produced results to answer the questions posed in this research regarding the cost of foods, the distances between households and stores, and the socioeconomics of communities on Oahu (synthesized in Table 6). The result are three displays of areas modelled to be food deserts generated using the variables, and corresponding weights, determined in the literature: one weighting cost distances and socioeconomics equally, and two emphasizing either cost distances or socioeconomics more heavily. The results are displayed in Maps 12 through 14.

To test how socioeconomic deprivation and cost distance affect modelling of a food desert on Oahu, three analyses were performed: weighing cost distance and socioeconomics equally, weighing cost distance more heavily, and weighing socioeconomics more heavily. This section addresses the final question in the objectives regarding overall socioeconomic and cost distance access. This chapter presents the results for each analysis, noting which communities stood out as having the most and least access to resources within each model and which communities surround areas with the most compromised access (i.e., "fringe communities"). The three models are then compared to see their similarities and differences, as well as areas that provide interesting points of contrast. Limitations of this study will also be discussed.

4.1. Summary of Socioeconomic Variables

The results of the socioeconomic analysis were discussed in the methodology chapter but are summarized in Table 6 to reference in the following sections. The variables are summarized to note which areas have the lowest and highest levels of access, areas that are considered fringe communities, as well as general patterns displayed in the data.

Table 6. Summary of the distribution of access by variable and area, including socioeconomic data and cost distance.

Variable	Areas with a rank of "5"	Fringe Communities	Areas with a rank of "1"	General patterns (levels of Access)
Weighted Income	Waipahu/Kunia	Schofield Base, Waimanalo, Kalihi, Kaimuki	No areas	Most of the island is in the 2 or 3 ranking
Per capita income	Waipahu/Kunia, Kalihi	Urban Honolulu, Haleiwa, Makaha, Nanakuli, Wahiawa, Schofield Base	East Honolulu, Kaneohe, Mililani, Aiea/Moanalua	Most of the island is in the mid-high (2) range
Median Income	Very sparse areas in Urban Honolulu between Kalihi and Kaimuki/Palolo	Urban Honolulu, Kaaawa, Marine Corp Base Hawaii, Haleiwa, Makaha/Waianae, Wahiawa	Mililani, East Honolulu, Kapolei, Kaneohe	Mixed results throughout the island
Poverty	Waianae, Waipahu	Nanakuli/Waianae, Waipahu, Kalihi, Kaimuki, Haleiwa, Kahuku, Hauula	No areas	Most of the island is in the 2 or 3 ranking
Unemployment and Underemployment	No areas	Nanakuli, Wahiawa, Urban Honolulu, Kalihi, Kaimuki	No areas	Most of the island is in the 2 or 3 ranking
Unemployment	Waianae, isolated areas in Kalihi	Waianae/Nanakuli	Mililani Mauka, Waipahu/Kunia, Waimanalo, parts of Kaneohe, east Honolulu	Most of the island is in the 2 or 3 ranking
Underemployment	Isolated area in Kaimuki	North Shore	Waipahu/Kunia, Schofield	Much of the island is in the 2 or 3 ranking
Percentage of Native Hawaiian/Pacific Islander	Waianae coast especially within Nanakuli, North east Oahu, Waimanalo	None	East Honolulu, part of Kailua, Mililani Mauka	Most of the island is in the 2 or 3 ranking
Percentage of automobile access	Urban Honolulu, Kalihi and Kaimuki	None	Most of the island, even in areas far from the urban core such as Haleiwa	Most of the island has access to a vehicle
Education attainment weight	Waianae, Waipahu, Nanakuli, Aiea, Kalihi	Waimanalo, North Shore, Kapolei, Waipahu	Mililani Mauka, part of Kailua, East Honolulu	Most of the island is in the mid and mid-low range (3 to 4)
Elderly/Young Weight	Mililani Mauka, Marine Corp Base Hawaii, East Honolulu, Kalihi	Most of the island	Waimanalo, Schofield Base	Most of the island is in the mid and mid-low range (3 or 4)
Family Dynamics	None	Waianae/Nanakuli, Kalihi, Kaimuki, Waimanalo	Kapolei, Kaneohe	Most of the island is in the mid-high range (2)

Number of People in household	Nanakuli, Waipahu, Kalihi	Waimanalo, Wahiawa, Pearl City	East Honolulu, Waipahu	Most of the island is in the mid high range (2)
Immigrants	Waipahu, Kalihi, Kaimuki, isolated area of Laie	None	None	Most of the island is in the high and mid high range (1 or 2)
Single Parent Household	Waipahu, Marine Corp Base Hawaii, Urban Honolulu, Wahiawa, Waianae/Nanakuli, Aiea	No areas	Kaneohe, Kapolei, parts of Mililani	The island has very mixed areas
Community Wealth	Waipahu, Nanakuli, Waianae	No areas	East Honolulu, Haleiwa parts of Mililani	Most of the island is in the middle range
Home value	Nanakuli, Waianae, Waimanalo, North East Oahu, Wahiawa, parts of Urban Honolulu	No areas	Kailua, Kaneohe, East Honolulu	Most of the island is in the median range with a rank of 3
Public Assistance	Kapolei, Waianae, Nanakuli	Waimanalo, parts of the North Shore, Kalihi	Most of the island	Most of the island is in the mid high to high range (1 or 2)
Tenure	Military Bases (Schofield, Marine Corps Base)	Aiea, Kailua, Kaneohe	Waipahu, Kailua, Kaneohe	The island is very mixed
Home Owner	Waipahu/Kunia, Military Bases (Schofield, Marine Corps Base), Kailua, urban Honolulu	Urban Honolulu, Aiea, North Shore	Kaneohe	The island is very mixed but much of the island is in the mid high range (2)
School lunch	West Oahu, Kalihi	Most of the island except those in the “5” and “1” range	Mililani	Most of the island is in the mid and mid-low range except Mililani, Kailua, Aiea, and East Honolulu
Community Health	Schofield Base, part of Wahiawa	North Shore, Kaneohe, Waimanalo	East Honolulu, Mililani, most of Honolulu	Most of the island is in the mid and mid high range (2 or 3)
Chronic Health	Wahiawa	West Oahu, North Shore, east Oahu	Mililani	The island is mixed with much of the island in the mid to mid low range (3 to 4 ranking)
Disabled	Schofield, Waipahu	No areas	Kailua	Most of the island is in the mid to mid high range (2 or 3 ranking)
Cost Distance	Aiea/Waimalu, Kaimuki, Kalihi, Kailua	Waialae, Kailua	Mililani Mauka, East Honolulu	Most of the island has sufficient access to food retailing and is in the mid to mid high range (2 or 3)

4.2. Weighing Socioeconomics and Cost Distance Equally

The first overlay weighed socioeconomic deprivation and cost distance equally and four classes of access were generated: high, mid-high, mid-low, and low. The results were discrete even within communities and most areas do not fit solely in one classification as displayed in Map 12 titled *Oahu Food Deserts*. The variety of access can be attributed to: 1) multiple stores in within communities with varying prices (e.g., Kailua), 2) distances between residences and stores (e.g., Waianae), 3) larger communities having varied socioeconomic backgrounds (e.g., Mililani). Though most communities cannot be compartmentalized to fit perfectly within each ranking, general patterns are present.

Mililani, east Honolulu, and Kaneohe have the best overall access and are less likely to be classified a food desert due to the abundance of supermarkets, with varying price points, and a high socioeconomic status. Moderately high access to supermarkets is present in parts of east Honolulu, northeast Oahu from Hauula through Kahaluu, parts of Waimanalo, most of Honolulu, parts of Kapolei, and parts of Wahiawa.

Areas with moderately low access to supermarkets are generally close to areas with low access, referred to as "fringe communities." These areas are in east Oahu between Kaneohe and Kailua, Aiea, much of the north Shore, and most of west Oahu from north Kapolei through Makaha. There are several reasons as to why these areas are modelled to have higher levels of deprivation, but are not considered the most deprived: 1) they contain stores with better prices, but residents are far from stores, 2) they have a lower socioeconomic status, and 3) they lack a variety of stores.

Areas with the lowest access were in Waimalu/Aiea, Kailua, parts of central Honolulu such as Kalihi and Kaimuki, Nanakuli, and Waipahu. Reasons that these neighborhoods stand out

as having poor access vary, provide an interesting examination as to what characteristics identify a food desert, and challenge the validity of the model. When looking at income, the heavily weighted socioeconomic variable, areas like Kailua and much of west Oahu are all in the mid to mid-high ranges of access but modelled physical access is inconsistent. Kailua could be considered a "food swamp" with a wide variety of stores present in the community, from inexpensive chain stores (e.g., Safeway) to specialty stores (i.e., Down to Earth and Wholefoods). Since the model allocates each residence to the nearest store, residences were allocated with no consideration to the market basket thus creating a high cost distance even if residences are close to several stores. In contrast, in west Oahu stores are fewer, and as well as the area has a lower socioeconomic status. Kalihi, Kaimuki, and Waipahu provide insight into the importance of socioeconomics. Like Kailua, each of these areas have an abundance of supermarkets and could be considered "food swamps" but their food desert scores are higher due to their socioeconomic status, particularly regarding income. These anomalies are displayed in Map 11 titled *Cost Distance and Store Locations* which overlays the cost distances with store locations. Urban Honolulu and Kailua are displayed in the inset which shows that despite each area having pockets of high cost distances, the areas have an abundance of retailing options. Each of the most deprived communities provide significant contrasts and critiques to the definition of food desert, the variables input into the model, and the overall effectiveness of the model.

A community that stood out within this analysis was Wahiawa, which is geographically isolated from its nearest communities. Within Wahiawa, every gradient of access from very high to very low is present. This variation is attributed to the presence of two stores with higher and lower price points, and varying socioeconomic statuses within the community. Similarly, Mililani

also had a variety of access, though was devoid of areas with the lowest scores; this can be attributed to the presence of stores with varying market baskets and the variety of socioeconomic scores within the community.

The second overlay weighed socioeconomic deprivation (0.75) as three times more important than cost distance (0.25) high, mid-high, mid-low, and low access areas. Despite the shift of the value of the variables, the analysis mirrored the results of the analysis which weighed socioeconomic deprivation and cost distance equally and is displayed in Map 13 titled *Oahu Food Deserts Socioeconomic Deprivation*.

4.3 Emphasizing Cost Distance

The final overlay weighed cost distance three times more heavily (0.75) than socioeconomic deprivation (0.25). Similar to the other analyses, access varied throughout communities as displayed in Map 14 titled *Oahu Food Deserts Cost Distance.* Much of the results from the analysis were comparable to the analysis where socioeconomics and cost distance were weighed equally. Areas with the greatest access were concentrated in Mililani, east Honolulu, and Kaneohe which had an abundance of food stores with varying prices.

Moderate and moderately high access was present in eastern Oahu from Hauula through Waimanalo except areas around Kailua. Greater access in these areas was attributed to the presence of moderately priced food retailing like Times/Shima's and Tamuras. Areas with moderately low access were located near Kailua, parts of east Honolulu, Aiea, and nearly all west Oahu. Patterns were similar between equal and cost distance emphasized measures of access except west Oahu, which had better access, and part of east Honolulu, which had worse access. Both Mililani and Wahiawa continue to have a mix of areas with high and low levels of access.

Areas modelled to have the worst access are concentrated in Aiea, Kailua, Waipahu, Kaimuki, and Kalihi. Many of these areas were modelled as having low access due to higher cost distances, which is mostly the result of more expensive baskets such as in WholeFoods and Down to Earth; this is present in Aiea, Kailua, and Kaimuki. This can be viewed as a false positive because these areas do have access to many retailing facilities, and in some instances, are swamped with food choices. Areas like Kalihi have poor areas, demonstrated in the income analysis, which impacts its ranking as a food desert in all models. However, this gives a simplification of access as there are food stores within the area and even across the street (i.e., walking distance) from impoverished areas like the Mayor Wrights Public Housing.

The model claims that few areas have impediments in obtaining healthy food as a function of socioeconomics, distance to food retail, and food costs, including: Kalihi, Kaimuki, Kailua, parts of Wahiawa, Waipahu, the north shore, and west Oahu from Kapolei through Waianae. These areas are modelled as food deserts when utilizing the predefined specifications regarding physical and socioeconomic access, but have not been verified using ground truthing beyond the market basket.

4.4. Synthesis

When synthesizing data from the socioeconomic characteristic overlays, and the three overlays emphasizing socioeconomic and cost distance, certain variables and patterns are prominent. First, certain communities continuously stand out as having low access throughout much of the analysis even when changing the emphasis of the cost distance. To contrast the previous point, it is also important to acknowledge the significance of socioeconomics as many communities with moderate to moderately high access shifted when factoring income.

The composite food desert overlay varied across Oahu, but patterns did emerge. Generally, areas that were modelled to have the lowest access were surrounded by areas with low, but not the lowest, levels of access; this is present on West Oahu, within urban Honolulu, Kailua, and the North Shore. These areas have a "peak" (i.e. Census Block Group or cluster of Census Block Groups) modelled to have low access, surrounded by areas with slightly better access. Some communities, however, have more discrete patterns such as in in Mililani and Wahiawa (which are both discussed as having mixed results) along with Aiea/Pearl City, which has a cluster of Census Block Groups with very low access, surrounded by areas with significantly better access. No areas within this research were modelled to have low access for every socioeconomic and cost distance measure, therefore, there is no threshold and as such the results (i.e., areas) are analyzed in relationship to one another rather than on a set scale.

Throughout the literature, researchers focused on utilizing the distance between communities/residences and food stores. When looking solely at cost distance, communities in west Oahu, North Shore, east Oahu, and Waipahu, have moderate to moderately high levels of access. However, when factoring socioeconomics, some of these areas, particularly west Oahu, North Shore, and Waipahu, have dramatically lower levels of access. Waipahu is an example of the contrast as it had a high level of physical access demonstrated in the cost distance analysis, but had consistently low rankings when combining socioeconomics and distance. Kailua serves is a counterpoint to Waipahu as Kailua scores in the moderate to moderately-high range socioeconomically but the high cost distance caused its deprivation level to be ranked high, though this was an oversimplification.

While it is important to be cognizant of areas with extreme deprivation, it is important to also be aware of "fringe communities." Fringe communities are those that are geographically

near areas with a high level of deprivation, Waianae is an example where parts of the community are wealthier and have moderately better access, measured by the cost distance, compared to areas like Nanakuli. However, it is important to delve further into the characteristics of these two neighborhoods. Waianae has slightly better access because it contains the lone supermarket on west Oahu after Kapolei. If this store were to go out of business, much of west of Oahu would have similar access as Nanakuli as the socioeconomics in Waianae are similar.

Communities like Wahiawa and Mililani provide an interesting view of differences within communities. Both communities are relatively geographically isolated from much of the island as they are separated by highways, bridges, and freeways. Within these communities, there are five supermarkets, three in Mililani and two in Wahiawa. These communities could be oases with the abundance of resources but when considering socioeconomics these communities paint a different picture. Most of Mililani and Wahiawa is in the moderate range for income, with a few isolated incidences of moderately high income levels. However, when considering other socioeconomic factors, there is more variety in levels of access. This emphasizes the notion that other factors besides cost distance, concentration of stores, and income can impact access. Some socioeconomic variables that stand out are health statistics for Wahiawa, which ranked at the very bottom of the entire state. Overall community wealth also scored in the moderate to moderately low rankings for each community.

CHAPTER 5: SUMMARY AND DISCUSSION

This study sought to test a model that determines which areas on Oahu have the greatest challenge in accessing healthy food sources, within supermarkets, as determined by distance, food costs, and socioeconomics. Food desert studies were synthesized to investigate the concept of food deserts and food security on Oahu.

To model physical access, cost distances were generated by mapping residences and supermarkets, identifying the cost of goods at supermarkets, then combining the two to generate a cost distance, based on the measure in Hallet and McDermott (2011). This required locating residences and stores and calculating how far people travel to the nearest store. A market survey established the cost of a basket of foods at each market. To determine socioeconomic access, eighteen variables were overlaid to generate community profiles on Oahu to determine which are the most disadvantaged. Physical and socioeconomic access were overlaid with three weighting schemes: equal weights, and with each type of access weighted more heavily.

The average distance between residences and supermarkets is 1.23 miles and the average cost distance is $184.39. Over half of all the stores (e.g., Safeway, Times, Tamuras, Pacific Supermarket, Costco, Sam's Club, Marukai, and Seafood City) on Oahu have a cost distance below average, and are spread throughout Oahu. If we relax the market basket cost to slightly above the average cost distance (i.e., $190- Foodland, Don Quijote, and Marukai) an additional 22 stores fall under the threshold, covering eighty-one percent of all supermarkets and nearly the entire island. This coverage begs the question of whether food deserts are an issue on Oahu and the usefulness of an all-encompassing measure. In calculating cost distance, this modelling exercise did not account for the impact of store density within communities, resulting in a misleading identification of areas like Kailua and Kaimuki to be categorized as food deserts.

The results were similar across the three models. Communities like Nanakuli, Aiea, Kaimuki, Kalihi, Waipahu, and Kailua were modeled as food deserts in each of the analyses. Large stretches of land that could be considered "fringe communities" are within the North Shore, west Oahu, and areas around Kailua and Kaneohe and urban Honolulu. Some of these areas are vulnerable because the loss of one store could negatively impact access within these communities, pushing moderately vulnerable communities to extreme vulnerability, creating larger swaths of land with less access. However, some of these areas were identified as food deserts because of restrictive cost distance measurement, which does not account for retail density and areas may be "swamped" with a plethora of food options, as present in Kailua and Kaimuki. Mililani, east Honolulu, and Kaneohe have the best access, and are least likely to be modeled as food deserts, though there was a lack of consistency within the communities.

Wahiawa and Mililani served as two interesting contrasts regarding access within communities. Wahiawa had every gradient of measure determining whether an area would be considered a food desert, or not, while Mililani did not have the highest measure of a food desert within its community, but there were some "fringe" areas. These communities demonstrate how measuring physical access, food costs, and socioeconomics can change modeled access within communities. Both communities contain multiple supermarkets, so physical access is not the utmost concern but pockets of low socioeconomic status within each community diversify the fabric of the community. Both communities had moderate to moderately high access when only considering cost distance but when overlaying with socioeconomic data, Mililani had some areas of moderately low access while Wahiawa had a few pockets of extremely low access.

The model generated results based on given socioeconomic, cost, and distance measures mentioned in the literature. While the model generates results, the results were not verified using

ground truthing and are not necessarily indicative of whether an area is a food desert. The model presents biases regarding variable selection and weights, and the exclusion of important and harder to measure variables like discretionary income, commuting patterns, and alternative transportation. This modeling exercise focused primarily on comparing access between communities using cost distance and socioeconomics, rather than providing specific thresholds in which an area needs to meet to qualify as being identified as a food desert. Overall, access may be slightly more challenging in some areas, but access is mostly present throughout Oahu, even in socioeconomically disadvantaged areas like Kalihi and rural areas like the North shore.

5.1. Discussion

The lack of studies on the topic of food deserts on Oahu was motivation for completing the modelling exercised but also served as a challenge as no research in Hawaii was available to build upon. This created some limitations within the study including: possible geocoding errors, selection/omission of socioeconomic variables and their overlay, market basket selection/food preferences, and cost distance measures. This exercise found several methodological problems in the use of market basket to determine cost distance. Some of these concerns could be addressed in further research, particularly to find a model that will better fit Hawaii, particularly on neighbor islands where access may be more compromised than on Oahu.

5.1.1. Data Limitations

Care was taken to minimize errors in the data in every stage though human and mechanical errors could be present and it is important to acknowledge possible discrepancies. Geocoding was challenging as some supermarkets were not located using ArcGIS, and were located manually utilizing rooftop location in Google Earth. All locations were checked manually and it appeared all establishments were sufficiently matched. Geocoding residences

was challenging due to the lack of appropriate metadata including the improper identification of tax map keys as having a living unit that do not exist. Some of these "false positive" areas were obvious as they were located far from population centers, and confirmed with City and County data, however it was deemed impractical to check each over 100,000 parcels. This could impede the analysis as units without inhabitants are counted and there is no emphasis on units with more inhabitants and squatter and homeless populations were not used. Some residences were non-traversable as they were not located near the road and are excluded in the analysis. Additionally, the military presence on Oahu also served as a data impediment because residences cannot be mapped due to data sensitivity and many of the socioeconomic variables are incomplete (i.e., median home value and homeownership). The model lacked data for new developments.

5.1.2. Model Limitations

Julie Guthman provides a critique of spatial analyses measuring obesogenic environments in her book *Weighing In,* which she refers to as the struggles of coproduction, or the analysis of the assumption of objects causes and corresponding characteristics being built into models and to examining them. The fallacy of these models is that variables utilized, and weights given, are determined by the researcher thus operationalizing patterns that oversimplify the real world. These spatial analyses display communities, but produce mixed results in demonstrating associations between measures but not measuring human behavior, such as food preferences.

The model used approaches modified from Bell et al. (2007) and Gould et al. (2012) where the variables are weighed per the number of times it was mentioned in the literature, then overlaying the data with physical measures. This model is a simplification of the real world as other variables could have been used but not every component that can be mapped is useful and will produce better insights regarding access.

The inclusion of socioeconomics provides two significant challenges, first, the inclusion of variables that may not be indicative of vulnerability on Oahu, and the exclusion of important socioeconomic measures that are harder to measure. Eighteen variables were categorized and mapped but few variables presented vulnerability outside a few isolated communities which questions the relevance of the utilization of these variables. Additionally, several variables were weighted heavily but few areas were identified as vulnerable which is problematic in the inclusion of income measures and vehicle access.

Some important socioeconomic measures that were excluded are challenging to measure as they focus on individual household characteristics like disposable income, living arrangements (e.g., multigenerational homes), commuting patterns, and public transportation access. Some data may be redundant regarding the incorporation of two measures of income (median household income and per capita income), and characteristics like poverty and public assistance, though the literature does mention these variables separately.

Discretionary income is difficult to obtain because there are many factors including income and housing costs. Measures like income may be insufficient in these homes as some households may have lower incomes but fewer expenses, while other households may have higher incomes but more expenses. Some researchers indicate that larger households can impede access but this may not be true as larger households could also split costs and enable bulk purchases, such as those from Costco and Sam's Club. Populations that were thought to be a concern in the model, particularly elderly residents, could live with adult children or grandchildren who are their caretakers. The ratio between market basket costs and discretionary income would be a better measure of access, as some communities may have a store with a more expensive basket but discretionary income is higher, therefore the higher cost is irrelevant.

Transportation is mentioned in the literature as a vital component of access though only automobile access was utilized which excluded those who utilize public transportation, walk, or combine shopping trips with friends or family members. When modelling vehicle access on Oahu, ownership is widespread, therefore utilizing this variable to measure access is not useful. The lack of analyzing alternative means of transportation heavily impacts measures of access on Oahu, not just in the urban core. Oahu's bus service TheBus serves the entire island, including the Waianae coast, North shore, and urban core. Communities like Kalihi and Kaimuki, have several bus lines operating continuously and some residents within urban Honolulu can walk to the nearest supermarket (i.e., Mayor Wrights Public Housing residents in Kalihi).

Commuting patterns were also not accounted for. For example, a resident in Waianae may work in urban Honolulu and on stop at stores on their way home to complete their grocery shopping for the week; but the model may have shown that this resident lacks access from their residence. The model does not account for individuals who may purchase food from several places based on prices and product preference.

While cost and distance are important, they are not the only factors in accessing food. Store density was not accounted for in the model, which is important in some communities that were modelled as a food desert, but are really "food oases." The outcomes generated reveal the shortcomings of the model, particularly the strict application of allocating residences to the nearest store without accounting for the cost of the market basket. Several issues arose in the compilation of the market basket, impacting the cost distance. The primary concerns include the restrictiveness of the market basket, the lack of consideration to alternative methods of obtaining food, and using the resulting cost distance in conjunction with discretionary income.

The restrictiveness of the market basket is due to the utilization of select products, without consideration to preference, and is based on consumption patterns provided by the USDA. Only non-sale prices were used and some families may base purchases on sales, and produce prices are affected by seasonality. The quality of products was also not considered in the compilation of a market basket and prices may be lower at establishments, but may not be as fresh at places where costs are higher. Some supermarkets may also tout themselves on providing foods that are local or organic, which some consumers may perceive as better quality and worth the price difference. In addition, the lack of products like animal products at Down to Earth provide a prohibitive cost distance are not reflective of prices people may pay. Future study could address this by incorporating the price at the nearest store with that product, coupled with the cost of travelling to that store.

Plant based diets (e.g., vegan and vegetarian), diets with limitations (e.g., gluten free), or diets for picky eaters are not accounted for in this model. This challenges the model because diets such as plant based diets may be more cost-effective than diets that include meat. Preference is a complicated to incorporate as it is individual to consumers, and the choices and decisions consumers make are based on experiences regarding food. A key component in food security is preference, which is difficult to measure, summarize, and compartmentalize into a spatial analysis; neither food prices nor distance are always a deciding factor. For example, a health-conscious Mililani resident working in Urban Honolulu could be willing to drive to and pay extra at a store she perceives as having better products. She shops at Sam's Club for animal proteins like chicken and fish since they are cheaper in bulk which is about 5 miles away from her home, but makes the monthly trip on her way home from work. She also incorporates plant based proteins which are cheaper, and have better selection at Down to Earth, which is locally

owned. She could go to the one in town, which is within walking distance from her job, but goes to Kapolei on days she is in the area for other shopping. Her experience is individual and based on cost, distance, ownership, and perceived quality. Future studies could survey households regarding preferences and transportation patterns.

The compilation of the market basket also does not account for alternative methods of obtaining food such as Farmer's and People's Open Markets. These markets provide cost effective prices for produce and is available throughout the island including urban Honolulu and the Waianae cost, but is limited with providing services to the north shore. Some markets also double the value of SNAP benefits, enabling the most vulnerable consumers to obtain more healthy products for better prices.

In areas where many stores are clustered near to each other, consumers can easily go from one store that may not have the product, to one that does. This is prevalent in areas with specialty stores, which had expensive market baskets due to the lack of products used to benchmark this survey (i.e., Down to Earth and Palama Market) or the cost of premium products (i.e., Whole Foods and Nijiya); this was present in urban Honolulu and Kailua, as mapped in Map 13 titled *Cost Distance and Store Locations*. These stores are important because they provide products for consumers with specific diets like vegetarians and those seeking specialty products like Asian foods. Stores like Down to Earth, Whole Foods, and Kokua Market provide robust bulk aisles providing cost effective alternatives to packaged goods, enabling the consumer to only purchase what they need and minimize costs. These limitations be future analyses that other researchers could partake in, particularly in the revision of the market baskets and new baskets could be developed to accommodate those following a plant based diet and those seeking markets with ethnic foods.

Creating the cost distance based on the market basket, with no correlation to discretionary income, was another limitation of the model. Without accounting for density, even if certain areas were allocated to the most expensive store, some of these residents may have the purchasing power to enable the consumption of products from stores despite a higher basket. This may be especially problematic in areas where there is a concentration of many stores, particularly specialty stores; it can be assumed that developers who selected areas to place these stores did so knowing there is a demand for the store and products it contains.

The indices generated a display the social landscape of given areas which was meant to point out where areas of concern may be when considering and emphasizing specific variables. The overlay generated gives a measure of access within communities, but the model is hindered by the specifications fed into it. Weights were assigned according to how frequent the variable came up in the literature, rather than how relevant the variable is in Hawaii. Out of eighteen variables, only five demonstrated that there were areas that had higher level of vulnerability, and the most heavily weighted variable of income was not one of the variables identified as being a prominent measure of socioeconomic vulnerability on Oahu.

Regarding the socioeconomics, rankings were generated within variables, in relationship to one another, rather than based on a threshold or set standards. This is primarily because, except specific variables (i.e., poverty and the USDA Food Atlas) there are no thresholds. In addition, regression analyses may have further delved into the relationship between variables, however, the research objective did not seek to correlate variables to one another. This served as another limitation to the study, as it was assumed that each variable is in fact symptomatic of a food desert. Further studies could utilize regression analysis to investigate which socioeconomic variables correlate with access but a threshold of what constitutes as access would need to be set.

One of the greatest challenges of the modelling exercise was mixing of scales. Fortunately, physical access could be determined at the household level as TMK data from the City and County is an adequate proxy for households. The challenge was overlaying household data with socioeconomic data aggregated to larger areas such as Census Block Groups. ArcGIS software is capable of overlaying data with varying sizes, however, the objective of this research was to create a model that would identify areas that lack access to healthy food retailing. By leaving household access data at the TMK level, the resulting data would be more discrete and would make it more challenging to identify larger areas with or without access.

5.1.3. Strengths and Implications of the Study

While there were impediments and challenges faced in the research, particularly looking for food deserts in a place that does not produce any symptoms of it, the process behind producing the model can also be useful. Throughout the literature, most researchers focused either on socioeconomics, distance, or cost. This model incorporated all three and did base access only on consumers physical (distance) or financial (cost and socioeconomics) ability to obtain healthy foods. While the results indicate that the model did not produce tangible results for Oahu, the data generated can be useful for consumer's who may be looking for a price comparison of specific products in stores, as laid out in Tables 14 through 29 in Appendix B.

Although the model identified areas like Kalihi to be food deserts, which may not lack access to resources, non-profits can still use the data to ground truth and determine if the areas have pockets that lack access. Although supermarkets are present in these communities, non-profits such as The Roots Project are seeking to eliminate gaps in food access. Within their Roots Double Bucks Booth, the non-profit doubles SNAP benefits to enable recipients to double their benefits when purchasing fruits, vegetables, and other SNAP eligible products at certain farmer's

markets. The Roots Project also provides a weekly booth at one of the public housing projects in the community to increase access to some of the poorest residents on Oahu (Friedheim, 2017).

Parts of the method (i.e., geocoding and network analysis) have been replicated for further studies. The methods used to locate stores have been used to locate all food establishments on Oahu using data from the State Department of Health, in addition to patient address data. The network analysis methods derived distances between establishments and residences to determine patient access. This is part of an ongoing funded study at the University of Hawaii at Manoa under the Office of Public Health

The lack of consensus in the literature regarding what constitutes as a food desert, and corresponding thresholds regarding distance, cost, and socioeconomics, was a challenge when developing the model for this research. This indicated that correlating variables with access may not produce a positive relationship between socioeconomics and access on Oahu. Consideration to variables, weighing entities differently, and the utilization of several scales and overlay analyses could dramatically change which areas are modelled as food deserts on Oahu. Despite the challenges, the model generated three iterations of food deserts on Oahu, though the results were slightly different from one another. Areas modelled as lacking access tended to be in clusters with a "peak" containing very low access, surrounded by "fringe communities" with slightly better access; these areas were modelled on the Waianae coast, Kalihi, Kaimuki, and Kailua. Despite the results generated, knowing that the average distance between a household and stores is only 1.23 miles on Oahu, and viewing the location of stores (Appendix C, Map 3 and Map 11), it can be inferred that access is present throughout Oahu even in poorer communities like Kalihi and rural communities in the North Shore. Food deserts may not be present on Oahu because of widespread access, therefore the model is not relevant for Oahu.

APPENDIX A. STORE DATA

Table 7. List of all stores.

Establishment Name	Street No.	Street Name	City	Zip
COSTCO WHOLESALE #1038	4589	KAPOLEI PARKWAY	KAPOLEI	96707
COSTCO WHOLESALE #120 (FOOD COURT)	333A	KEAHOLE STREET	HONOLULU	96825
COSTCO WHOLESALE #120 (WAREHOUSE)	333A	KEAHOLE STREET	HONOLULU	96825
COSTCO WHOLESALE #687 (WAREHOUSE)	525	ALAKAWA STREET	HONOLULU	96817
COSTCO WHOLESALE WAREHOUSE #485	94-1231	KA UKA BOULEVARD	WAIPAHU	96797
DON QUIJOTE	94-144	FARRINGTON HIGHWAY	WAIPAHU	96797
DON QUIJOTE	850	KAMEHAMEHA HIGHWAY	PEARL CITY	96782
DON QUIJOTE – KAHEKA	801	KAHEKA STREET	HONOLULU	96814
DOWN TO EARTH ALL VEGETARIAN, ORGANIC &	4460	KAPOLEI PARKWAY	KAPOLEI	96707
DOWN TO EARTH FOODS	2525	SOUTH KING STREET	HONOLULU	96826
DOWN TO EARTH NATURAL FOODS AIEA	98-129	KAONOHI STREET	AIEA	96701
DOWN TO EARTH ORGANIC & NATURAL	201	HAMAKUA DRIVE	KAILUA	96734
FOOD PANTRY #1003 EATON SQUARE	438	HOBRON LANE	HONOLULU	96815
FOOD PANTRY KUHIO	2370	KUHIO AVENUE	HONOLULU	96815
FOODLAND FARMS	820	WEST HIND DRIVE	HONOLULU	96821
FOODLAND SUPER MARKET #1 (MARKET CITY)	2939	HARDING AVENUE	HONOLULU	96816
FOODLAND SUPER MARKET #10	823	CALIFORNIA AVENUE	WAHIAWA	96786
FOODLAND SUPER MARKET #16	91-1401	FORT WEAVER ROAD	EWA BEACH	96706
FOODLAND SUPER MARKET #18	1505	DILLINGHAM BOULEVARD	HONOLULU	96817
FOODLAND SUPER MARKET #19 MILILANI	95-221	KIPAPA DRIVE	MILILANI	96789
FOODLAND SUPER MARKET #2	414	NORTH SCHOOL STREET	HONOLULU	96817
FOODLAND SUPER MARKET #27 PUPUKEA	59-720	KAMEHAMEHA HIGHWAY	HALEIWA	96712
FOODLAND SUPER MARKET #31	94-1040	WAIPIO UKA STREET	WAIPAHU	96797
FOODLAND SUPER MARKET #32 (LAIE)	55-510	KAMEHAMEHA HIGHWAY	LAIE	96762
FOODLAND SUPER MARKET #4	1460	SOUTH BERETANIA STREET	HONOLULU	96814
FOODLAND SUPER MARKET #8 (KANEOHE)	45-480	KANEOHE BAY DRIVE	KANEOHE	96744
FOODLAND SUPER MARKET #9	1089	WAIMANO HOME ROAD	PEARL CITY	96782
FOODLAND SUPERMARKET	4850	KAPOLEI PARKWAY	KAPOLEI	96707
FOODLAND SUPERMARKET #37	108	HEKILI STREET	KAILUA	96734

GRILL CITY/SEAFOOD	94-050	FARRINGTON HIGHWAY	WAIPAHU	96797
KOKUA MARKET	2643	SOUTH KING	HONOLULU	96826
MARUKAI – WARD	1020	AUAHI ST	HONOLULU	96814
MARUKAI WHOLESALE MART	2310	KAMEHAMEHA	HONOLULU	96819
NIJIYA MARKET – UNIVERSITY	1009	UNIVERSITY	HONOLULU	96826
NIJIYA MARKET - ALA MOANA	451	PIIKOI STREET	HONOLULU	96814
PACIFIC SUPERMARKET	94-300	FARRINGTON	WAIPAHU	96797
PALAMA MARKET – KALIHI	1070	N KING STREET	HONOLULU	96817
PALAMA MARKET – TOWN	1670	MAKALOA STREET	HONOLULU	96814
PALAMA SUPERMARKET SNACK CORNER	98-020	KAMEHAMEHA	AIEA	96701
SACK & SAVE	87-2070F	FARRINGTON	WAIANAE	96792
SACK 'N SAVE #36	4561	SALT LAKE	HONOLULU	96818
SAFEWAY #2747	888	KAPAHULU	HONOLULU	96816
SAFEWAY #2897	91-1119	KEAUNUI DRIVE	EWA BEACH	96706
SAFEWAY #2944	1234	SOUTH	HONOLULU	96814
SAFEWAY STORES #1087 KAILUA	200	HAMAKUA DRIVE	KAILUA	96734
SAFEWAY STORES #1263	91-590	FARRINGTON	KAPOLEI	96707
SAFEWAY STORES #203	1360	PALI HIGHWAY	HONOLULU	96813
SAFEWAY STORES #204	2855	EAST MANOA	HONOLULU	96822
SAFEWAY STORES #205	1060	KEOLU DRIVE	KAILUA	96734
SAFEWAY STORES #207	46-065	KAMEHAMEHA	KANEOHE	96744
SAFEWAY STORES #215	377	KEAHOLE STREET	HONOLULU	96825
SAFEWAY STORES #2208	25	KANEOHE BAY	KAILUA	96734
SAFEWAY STORES MILILANI #2218	94-780B	MEHEULA	MILILANI	96789
SAFEWAY STORES WAIMALU #214	98-1277	KAAHUMANU	AIEA	96701
SAFEWAY STORES, INC. #211 SALT LAKE	848	ALA LILIKOI	HONOLULU	96818
SAMS CLUB KEEAUMOKU	750	KEEAUMOKU ST	HONOLULU	96814
SAM CLUB PEARL CITY				
SEAFOOD CITY	94-50	FARRINGTON	WAIPAHU	96797
SHIMA'S MARKET	41-1606	KALANIANAOLE	WAIMANALO	96795

Establishment Name	Street No.	Street Name	City	Zip
TAMURA'S HAUULA	54-316	KAMEHAMEHA HIGHWAY	HAUULA	96717
TAMURA'S KALAELOA	91-1051	ENTERPRISE AVENUE	KAPOLEI	96707
TAMURA'S WAHIAWA	440	KILANI AVENUE	WAHIAWA	96786
TAMURA'S WAIANAE	86-032	FARRINGTON HIGHWAY	WAIANAE	96792
TIMES SUPER MARKET - MILILANI	95-1249	MEHEULA PARKWAY	MILILANI	96789
TIMES SUPER MARKET #12	98-1264	KAAHUMANU STREET	PEARL CITY	96782
TIMES SUPER MARKET #14	3221	WAIALAE AVENUE	HONOLULU	96816
TIMES SUPER MARKET #18 (ROYAL KUNIA)	94-615	KUPUOHI STREET	WAIPAHU	96797
TIMES SUPER MARKET #3	590	KAILUA ROAD	KAILUA	96734
TIMES SUPER MARKET KAMEHAMEHA	1620	NORTH SCHOOL STREET	HONOLULU	96817
TIMES SUPER MARKET, LTD. #1	1772	SOUTH KING STREET	HONOLULU	96826
TIMES SUPER MARKET, LTD. #10	47-388	HUI IWA STREET	KANEOHE	96744
TIMES SUPER MARKET, LTD. #11	1425	LILIHA STREET	HONOLULU	96817
TIMES SUPER MARKET, LTD. #2	1173	21ST AVENUE	HONOLULU	96816
TIMES SUPER MARKET, LTD. #4	45-934	KAMEHAMEHA HIGHWAY	KANEOHE	96744
TIMES SUPER MARKET, LTD. #6	94-766	FARRINGTON HIGHWAY	WAIPAHU	96797
TIMES SUPER MARKET, LTD. #8	1290	SOUTH BERETANIA STREET	HONOLULU	96814
TIMES SUPER MARKET, LTD. #9	99-115	AIEA HEIGHTS DRIVE	AIEA	96701
WHOLE FOODS MARKET	629	KAILUA ROAD	KAILUA	96734
WHOLE FOODS MARKETS	4211	WAIALAE AVENUE	HONOLULU	96816

Table 8. Store visit data.

Establishment Name	LOCATION	Visit Date (2016)	Visit Partner	Revisit Date (2016)
COSTCO WHOLESALE WAREHOUSE #485	Waipahu/Waipio	31-Jan	Ayesha Ishihara	
DON QUIJOTE	Waipahu	30-Jan	Angela Boyle	
DOWN TO EARTH ALL VEGETARIAN, ORGANIC & NATURAL	Kapolei	30-Jan	Angela Boyle	
FOOD PANTRY KUHIO	Waikiki (Kuhio Ave.)	1-Feb		
FOODLAND SUPER MARKET #31	Waipio, Revisit: Mililani	23-Jan	Lisa Dau	10-Feb
GRILL CITY/SEAFOOD CITY SUPERMARKET	Waipahu	10-Feb		
KOKUA MARKET	Honolulu	1-Feb		
MARUKAI WHOLESALE MART	Honolulu (Auahi St.)	1-Feb		
NIJIYA MARKET	Honolulu (University Ave.)	1-Feb		
SAFEWAY STORES MILILANI #2218	Mililani	23-Jan	Lisa Dau	10-Feb
TAMURA'S KAPOLEI	Kapolei	30-Jan	Angela Boyle	
TIMES SUPER MARKET - MILILANI	Mililani	23-Jan	Lisa Dau	10-Feb
WHOLE FOODS MARKETS	Honolulu	1-Feb		
SAM'S CLUB PEARL CITY	Pearl City	31-Jan	Ayesha Ishihara	
PACIFIC SUPERMARKET	Waipahu	30-Jan	Angela Boyle	

APPENDIX B. THE MARKET BASKET

Table 9. List of Fruit products

Type	Subtype	Type	Price per unit (fresh)	price per ounce	Price per unit (frozen or canned)	price per ounce	Fresh or
Citrus, melon, berries (whole)	Melon						
	Oranges						
	Grapefruit						
	Lemon						
	Lime						
	Strawberries						
Other fruits	Bananas						
	Apples						
	Grapes						
	Papaya						
	Pineapple						
Fruit Juice	Grapefruit						
	Apples						

Table 10. List of Vegetable Products

Type	Subtype	Brand or Generic	Price per unit (fresh)	price per oz	Price per unit(frozen)	price per oz
Potatoes	Russet Potato					
	Asian Potato					
	Red/yellow potato					
Dark Green Veggies	Broccoli					
	Spinach					
	Kale					
Orange Veggies	Sweet Potato					
	Carrots					
	Pumpkin					
Other Veggies	Tomatoes					
	Corn					
	Onions					
	Peas					
	Green Beans					
	Celery					
	Cucumber					
	Zucchini					
	Mixed veggies					
	Cauliflower					
	Mushrooms					
	Bell Pepper (Green)					
	Bell Pepper (Other)					

Table 11. List of Grain Products.

Type	Subtype	Product	Brand or Generic	Price per unit	price per ounce
Whole grain bread, rice, pasta	Bread				
	Rice				
	Pasta				
	Tortilla or Wrap				
Whole Grain Cereals	Ready to Eat				
	Hot Cereal				
Popcorn and Whole Grain Snacks	Popcorn				
	Pretzel				
	Crackers				
None whole grain variety	Bread				
	Rice				
	Pasta				
	Tortilla or Wrap				
	Ready to Eat				
	Hot Cereal				
	Popcorn				
	Pretzel				
	Crackers				

Table 12. List of Meat products.

Type	Subtype	Product	Brand or Generic	Price per unit	price per ounce	Price per unit (Frozen)	price
Beef, pork, veal, lamb	Beef						
	Pork						
Poultry	Chicken						
	Turkey						
Fish	Canned tuna						
	Shellfish						
	white fish						
	Tuna						
	Salmon						
Packaged meats	Luncheon meat						
Legumes, meat alternatives	Bean variety						
	Lentil Variety						
	Tofu						
	Meat alternative						
Nuts and nut butters	Nut or seed mixture						
	nut butter						
Egg and egg mixtures	Eggs						
	egg substitute						

Table 13. List of Milk products.

Type	Subtype	Product	Brand or Generic	Price per unit	price per ounce
Whole milk products	Milk				
	Yogurt				
Nonfat milk products	Milk				
	Yogurt				
Cheese	Packaged cheese				

Table 14. Costco Market Basket

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Costco price	unit
Beef, pork, veal, lamb	Beef	93%	3.19/lb	17.39/5lbs	3.19	pounds
	Pork	Loin	1.99/lb		1.99	pounds
Poultry	Chicken	Boneless/Skinless//Tenderloin	3.29/lb	16.99/6lbs	2.8316667	pounds
	Turkey	Ground	2.99/lb		2.99	pounds
Fish	Canned tuna		12.99/12-7oz can		0.1546429	ounces
	shellfish	Shrimp	9.99	17.59/3lbs	5.8633333	pounds
	white fish	Tilapia/Ono	5.99/lb	17.59/3lbs	5.8633333	pounds
	tuna		13.99/lb		13.99	pounds
	salmon		8.99/lb	22.59/3lbs	7.53	pounds
Packaged meats	Luncheon meat	Extra lean ham	10.69 for 2/24oz		3.5633333	pounds
Legumes, meat alternatives	Bean variety	Dried pinto	26.89 for 50lbs		0.5378	pounds
	Lentil Variety	Prepared lentils	9.99 for 6x10oz		2.64	pounds
	tofu		6.39 for 4/14oz		0.1141071	ounces
	Meat alternative	Morning star sausage	14.19/42.8oz		0.3315421	ounces
Nuts and nut butters	Nut or seed mixture	Dried salted peanuts	7.59/52oz		0.1459615	ounces
	nut butter	PB	10.49- 2 28oz		0.1873214	ounces
Egg and egg mixtures	eggs		3.79/18 count		2.5266667	doz
	egg substitute	Kirkland brand	9.69/96oz		0.1009375	ounces
Whole milk products	Milk		4.29/gal		4.29	gal
Nonfat milk products	Milk		3.95/gal		3.95	gal
	yogurt		6.89/3lbs		0.1435417	ounces
Cheese	Packaged cheese		10.49/5lbs		0.131125	ounces
Citrus, melon, berries (whole)	Melon		5.99 ea		5.99	each
	Oranges		12.79/13lbs		0.9838462	pounds
	Grapefruit		8.99/8lbs		1.12375	pounds
	Lemon		7.99/5lbs		1.598	pounds
	Lime		7.99/5lbs		1.598	pounds
	Strawberries		8.99/2lbs	10.99/4lbs	2.7475	pounds
Other fruits	Bananas		1.89/3lbs		0.63	pounds
	Apples		9.99/5.5lbs		1.8163636	pounds
	Grapes		10.99/5lbs		2.198	pounds
	Papaya		6.99/5lbs		1.398	pounds
	Pineapple		2.99ea		2.99	each
Fruit Juice	Grapefruit		5.49/2-96oz		0.0285938	ounces
	Apples		7.69/2 gal		0.0300391	ounces
Potatoes	Russet Potato		11.99/20lbs		0.5995	pounds
	Asian Potato					pounds

Type	Subtype	Product	Price per unit	Price per unit	Costco price	unit
	Red/yellow potato		9.99/10lbs		0.99	pounds
Dark Green Veggies	Broccoli		5.99/3lbs	8.99/4lbs	1.9966667	pounds
	Spinach		4.99/2lbs		2.495	pounds
	Kale					pounds
Orange Veggies	Sweet Potato	organic	17.99/10lbs		1.799	pounds
	Carrots		5.99/10lbs		0.599	pounds
	Pumpkin					pounds
Other Veggies	Tomatoes		7.49/4lbs		1.8725	pounds
	Corn		5.99/2.5lbs	6.39/4lbs	1.5975	pounds
	Onions		8.99/10lbs		0.899	pounds
	Peas			6.99/5lbs	1.398	pounds
	Green Beans		5.99/2lbs		2.995	pounds
	Celery		3.99/2.5lbs		1.596	pounds
	Cucumber		6.99/2lbs		3.495	pounds
	Zucchini					pounds
	Mixed veggies			6.99/5lbs	1.398	pounds
	Cauliflower					
	Mushrooms		8.99/24oz		5.9933333	pounds
	Bell Pepper (Green)		5.99/6(5.8oz		2.754023	pounds
	Bell Pepper (Other)	Red	5.99/6		0.9983333	each
Whole grain bread, rice, pasta	Bread		5.35/2-32oz		0.1573529	ounces
	Rice		15.59/25lbs		0.6236	pounds
	Pasta					
	Tortilla or Wrap		7.69/2.73lbs		0.1760531	ounces
Whole Grain Cereals	Ready to Eat	Kashi Cinnamon	7.99/3.25lbs		0.1536538	ounces
	Hot Cereal		8.69/10lbs		0.869	pounds
Popcorn and Whole Grain	Popcorn		10.99/44 count- 9.05lbs		0.0758978	ounces
	Crackers		7.99/3.17lbs		0.1575315	ounces
None whole grain variety	Bread		4.95/2-24oz		0.103125	ounces
	Rice		17.49/15		1.166	pounds
	Pasta		9.99/8.8lbs		1.1352273	pounds
	Tortilla or Wrap		6.99/3lbs 15oz		0.1109524	ounces
	Ready to Eat	Frosted Flakes	6.89/3.87		0.1112726	ounces
	Hot Cereal					
	Crackers	Ritz	8.99/61.6oz		0.1459416	ounces

Table 15. Quijote Market Basket.

Type	Subtype	Product	Price per unit	Price per unit	price	unit
Beef, pork, veal, lamb	Beef	85%	5.39/lb		5.39	pounds
	Pork	Loin	2.99/lb		2.99	pounds
Poultry	Chicken	Boneless Skinless	5.99/lb	8.09/2.5lbs	3.236	pounds
	Turkey	Ground	7.69/lb		7.69	pounds
Fish	Canned tuna	Starkist	1.89/5oz		0.378	ounces
	shellfish	Shrimp	6.99/lb	7.49/lb	6.99	pounds
	white fish	Pollock	3.49/lb		3.49	pounds
	tuna		9.99/lb		9.99	pounds
	salmon		7.49/lb	5.49/lb	5.49	pounds
Packaged meats	Luncheon meat	Variety	12.09/24oz		8.06	pounds
Legumes, meat alternatives	Bean variety		1.39/15oz	3.99/2lbs	1.995	pounds
	Lentil Variety			1.99/lb	1.99	pounds
	tofu		1.99/14oz		0.1421429	ounces
	Meat alternative	Boca Burger	4.99/10oz		0.499	ounces
Nuts and nut butters	Nut or seed mixture	Peanuts	10.29/35oz		0.294	ounces
	nut butter		3.79/16oz		0.236875	ounces
Egg and egg mixtures	eggs		4.99/doz		4.99	doz
	egg substitute		6.99/32oz		0.2184375	ounces
Whole milk products	Milk		5.69/gal		5.69	gal
	Yogurt		3.99/32oz		0.1246875	ounces
Nonfat milk products	Milk		5.69/gal		5.69	gal
	yogurt		3.49/32oz		0.1090625	ounces
Cheese	Packaged cheese		9.99/32oz		0.3121875	ounces
Citrus, melon, berries (whole)	Melon	Watermelon	1.99/lb		1.99	pounds
	Oranges		6.99/4lbs		1.7475	pounds
	Grapefruit		1.99 ea		1.99	each
	Lemon		5.99/2lbs		2.995	pounds
	Lime		1.99/ea		1.99	each
	Strawberries		7.99/lb	3.89/16oz	3.89	pounds
Other fruits	Bananas		1.59/lb		1.59	pounds
	Apples		5.99/2lbs		2.995	pounds
	Grapes		5.99/lbs		5.99	pounds
	Papaya		1.79/lb		1.79	pounds
	Pineapple		1.39/lb		1.39	pounds
Fruit Juice	Grapefruit		5.69/64oz		0.1673529	ounces
	Apples		3.99/64oz		0.1173529	ounces
Potatoes	Russet Potato		6.99/10lbs		0.699	pounds
	Asian Potato		3.99/lb		3.99	pounds

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	price	unit
	Red/yellow potato		2.99/2lbs		1.495	pounds
Dark Green Veggies	Broccoli		3.99/lb		3.99	pounds
	Spinach		6.99/lb	1.99/10oz	3.184	pounds
	Kale		6.99/lb		6.99	pounds
Orange Veggies	Sweet Potato		3.99/lb		3.99	pounds
	Carrots		1.79/lb	2.39/12oz	1.79	pounds
	Pumpkin		1.99/lb		1.99	pounds
Other Veggies	Tomatoes		3.99/lb		3.99	pounds
	Corn		4.99/4pk		1.2475	each
	Onions		1.09/lb		1.09	pounds
	Peas			4.89/32oz	2.445	pounds
	Green Beans		3.99/8oz	2.59/16oz	2.59	pounds
	Celery		2.49/lb		2.49	pounds
	Cucumber		1.99/lb		1.99	pounds
	Zucchini		3.99/lb		3.99	pounds
	Mixed veggies			4.89/32oz	2.445	pounds
	Cauliflower		4.99/lb		4.99	pounds
	Mushrooms		6.99/lb		6.99	pounds
	Bell Pepper (Green)		2.99/lb		2.99	pounds
	Bell Pepper (Other)	Variety	5.99/lb		5.99	pounds
Whole grain bread, rice, pasta	Bread		3.19/16oz		0.199375	ounces
	Rice		17.99/20lbs		1.799	pounds
	Pasta		2.99/16oz		2.99	pounds
	Tortilla or Wrap		3.49/16oz		0.218125	ounces
Whole Grain Cereals	Ready to Eat		3.49/16.4oz		0.2128049	ounces
	Hot Cereal		4.99/42oz		1.9009524	ounces
Popcorn and Whole Grain Snacks	Popcorn		4.89/6 bags -		0.2328571	ounces
	Crackers		5.59/12oz		0.4658333	ounces
None whole grain variety	Bread		3.19/16oz		0.199375	ounces
	Rice		17.99/20lbs		0.8995	pounds
	Pasta		1.49/16oz		1.49	pounds
	Tortilla or Wrap		9.39/73.3oz		0.1281037	ounces
	Ready to Eat		5.88/32oz		0.18375	ounces
	Hot Cereal		2.29/20oz		0.1145	ounces
	Crackers		5.39/13.7oz		0.3934307	ounces

Table 16. Down to Earth Market basket.

Type	Subtype	Price per unit	Price per unit (Frozen)	Price	unit
Beef, pork, veal, lamb	Beef				
	Pork				
Poultry	Chicken				
	Turkey				
Fish	Canned tuna				
	shellfish				
	white fish				
	tuna				
	salmon				
Packaged meats	Luncheon meat				
Legumes, meat alternatives	Bean variety	2.19/15oz	1.79/lb bulk	1.79	pounds
	Lentil Variety		2.39/lb bulk	2.39	pounds
	tofu	2.29/14oz		0.1635714	ounces
	Meat alternative				
Nuts and nut butters	Nut or seed mixture				
	nut butter	7.49/18oz		0.4161111	ounces
Egg and egg mixtures	eggs				
	egg substitute				
Whole milk products	Milk	7.89/ half gal		15.78	gal
	Yogurt	5.99/32oz		0.1871875	ounces
Nonfat milk products	Milk	7.89/half gal		15.78	gal
	yogurt	5.39/24oz		0.2245833	ounces
Cheese	Packaged cheese	6.09/8oz		0.76125	ounces
Citrus, melon, berries (whole)	Melon	1.99		1.99	pounds
	Oranges	7.99/4lbs		1.9975	pounds
	Grapefruit	6.99/4lbs		1.7475	pounds
	Lemon	4.99/lb		4.99	pounds
	Lime	4.99/lb		4.99	pounds
	Strawberries		4.89/10oz	7.824	pounds
Other fruits	Bananas	1.39/lb		1.39	pounds
	Apples	9.99/3lbs		3.33	pounds
	Grapes				
	Papaya	1.99/lb		1.99	pounds
	Pineapple	0.99/lb		0.99	pounds
Fruit Juice	Grapefruit				
	Apples	6.79/50oz		0.1358	ounces
Potatoes	Russet Potato	1.99		1.99	pounds
	Asian Potato	2.99		2.99	pounds

Type	Subtype	Price per unit	Price per unit (Frozen)	Price	unit
	Red/yellow potato	1.99		1.99	pounds
Dark Green Veggies	Broccoli	3.99	4.19/10oz	3.99	pounds
	Spinach	9.99/10oz	5.49/16oz	5.49	pounds
	Kale	3.99/bu		3.99	bu
Orange Veggies	Sweet Potato	2.59		2.59	pounds
	Carrots	8.99/5lbs		1.798	pounds
	Pumpkin	2.59		2.59	pounds
Other Veggies	Tomatoes	3.99		3.99	pounds
	Corn		3.69/16oz	3.69	pounds
	Onions	1.99		1.99	pounds
	Peas		3.69/16oz	3.69	pounds
	Green Beans	3.99/0.33lb	3.69/16oz	3.69	pounds
	Celery	2.99		2.99	pounds
	Cucumber	2.99		2.99	pounds
	Zucchini	4.99		4.99	pounds
	Mixed veggies		3.69/16oz	3.69	pounds
	Cauliflower	4.99		4.99	pounds
	Mushrooms	6.99/lb		6.99	pounds
	Bell Pepper (Green)	3.99/lb		3.99	pounds
	Bell Pepper (Other)	6.99		6.99	pounds
Whole grain bread, rice, pasta	Bread	4.79/22oz		0.2177273	ounces
	Rice	1.49/lb		1.49	pounds
	Pasta	3.29/16oz		3.29	ounces
	Tortilla or Wrap	3.69/12oz		0.3075	ounces
Whole Grain Cereals	Ready to Eat	10.69/29.1		0.367354	ounces
	Hot Cereal	1.09/lb		1.09	pounds
Popcorn and Whole Grain Snacks	Popcorn	3.09/3pk		0.3121212	ounces
	Crackers	4.49/8.5oz		0.5282353	ounces
None whole grain variety	Bread	5.79/16oz		0.361875	ounces
	Rice	1.99/lb		1.99	pounds
	Pasta				
	Tortilla or Wrap	1.79/8oz		0.22375	ounces
	Ready to Eat				
	Hot Cereal				
	Crackers	3.99/8oz		0.49875	ounces

Table 17. Foodland Market Basket

Type	Subtype	Product	Price per unit	Price per unit	price	unit
Beef, pork, veal, lamb	Beef				6.29	
	Pork				4.99	
Poultry	Chicken				4.99	
	Turkey				4.19	
Fish	Canned tuna		2.09/5oz		0.418	
	shellfish	Shrimp	4.99/lb	8.99/lb	4.99	pound
	white fish	Marlin/Tilapia	3.99	5.49	3.99	pound
	tuna	Wild	7.99		7.99	pound
	salmon	Farmed	7.99	5.99	5.99	pound
Packaged meats	Luncheon meat			4.19/9oz	7.4488889	
Legumes, meat alternatives	Bean variety		1.49/15oz	3.69/lb	3.69	pound
	Lentil Variety			2.89/lb	2.89	pound
	tofu		1.50/10oz		0.15	ounces
	Meat alternative	Boca Burger	3.39/5.5oz		0.6163636	ounces
Nuts and nut butters	Nut or seed mixture	Peanuts	4.99/lb		0.311875	ounces
	nut butter			5.39/16oz	0.336875	
Egg and egg mixtures	eggs		3.59/1.5doz		2.3933333	doz
	egg substitute		3.49/16oz		0.218125	ounce
Whole milk products	Milk		6.39/gal		6.39	gal
	Yogurt		7.19/32oz		0.2246875	ounce
Nonfat milk products	Milk		6.39/gal		6.39	gal
	yogurt		3.89/32oz		0.1215625	ounce
Cheese	Packaged cheese		12.09/32oz		0.3778125	ounce
Citrus, melon, berries (whole)	Melon	Honeydew/Cantaloupe	2.29/lb		2.29	pound
	Oranges		7.29/4lbs		1.8225	pound
	Grapefruit		3.99/lb		3.99	pound
	Lemon		5.49		5.49	pound
	Lime		5.49		5.49	pound
	Strawberries		7.99/16oz	8.59/40oz	3.436	pound
Other fruits	Bananas		1.29		1.29	pound
	Apples		6.49/3lbs		2.1633333	pound
	Grapes		5.69/lb		5.69	pound
	Papaya		199		1.99	pound
	Pineapple		1.59		1.59	pound
Fruit Juice	Grapefruit		6.79/60oz		0.1131667	ounces
	Apples		8.19/gal		0.0639844	ounces

Potatoes	Russet Potato		3.99/5lbs		0.798	pound
	Asian Potato		2.89/lb		2.89	pound
Type	**Subtype**	**Product**	**Price per unit**	**Price per unit**	**price**	**unit**
	Red/yellow potato		7.29/5lbs		1.458	pound
Dark Green Veggies	Broccoli		4.29/lb	3.19/16oz	3.19	
	Spinach		5.39/8oz	2.09/10oz	3.344	
	Kale		7.69/10oz		7.69	
Orange Veggies	Sweet Potato		2.49/lb		2.49	pound
	Carrots		1.69/lb		1.69	
	Pumpkin		1.99/lb		1.99	
Other Veggies	Tomatoes		2.69/lb		2.69	
	Corn		5.49/4pk	4.39/2lbs	2.195	
	Onions		399/3lbs		1.33	pound
	Peas			4.39/2lbs	2.195	
	Green Beans		3.69/8oz	2.99/16oz	2.99	
	Celery		2.29/lb		2.29	pound
	Cucumber		2.29/lb		2.29	pound
	Zucchini		3.39/lb		3.39	pound
	Mixed veggies			4.39/2lbs	2.195	
	Cauliflower		3.69/lb		3.69	
	Mushrooms		7.29/lb		7.29	pound
	Bell Pepper (Green)		3.49/lb		3.49	pound
	Bell Pepper (Other)		5.99/lb		5.99	pound
Whole grain bread, rice, pasta	Bread		4.19/22oz		0.1904545	ounces
	Rice		14.99/15lbs		0.9993333	pound
	Pasta		2.89/13.25oz		3.4898113	pound
	Tortilla or Wrap		3.99/17.6oz		0.2267045	ounces
Whole Grain Cereals	Ready to Eat		4.29/16oz		0.268125	ounces
	Hot Cereal		5.99/42oz		2.2819048	pound
Popcorn and Whole Grain	Popcorn		3.49/3*2.9oz		0.4011494	ounces
	Crackers		3.99/8oz		0.49875	ounces
None whole grain variety	Bread		4.19/22oz		0.1904545	ounces
	Rice		14.99/15		0.9993333	pound
	Pasta		3.89/32oz		1.945	pound
	Tortilla or Wrap		4.89/20oz		0.2445	ounces
	Ready to Eat		5.89/28oz		0.2103571	ounces
	Hot Cereal		2.29/20oz		0.1145	ounces
	Crackers		3.49/1lb		0.218125	ounces

Table 18. Food Pantry Market Basket.

Type	Subtype	Product	Price per unit	Price per unit		
Beef, pork, veal, lamb	Beef	93%	7.99/lb		7.99	pounds
	Pork	Loin	5.49/lb		5.49	pounds
Poultry	Chicken	Boneless Skinless	5.99/lb		5.99	pounds
	Turkey	Tenderloin - 99% Fat	869 for 1.5lbs		5.9733333	pounds
Fish	Canned tuna		2.0/5oz		0.4	pounds
	shellfish	Shrimp	8.99/lb	16.99/lb	8.99	pounds
	white fish	Mahi/Flounder Cod	6.99/b	6.99/lb	6.99	pounds
	tuna		10.99/lb		10.99	pounds
	salmon		14.99/lb	9.99/1.25lbs	7.992	pounds
Packaged meats	Luncheon meat	Foster Farm Variety	4.49/12oz		4.49	pounds
Legumes, meat alternatives	Bean variety	Variety/Pinto	1.79/15oz	3.59/lb	3.59	pounds
	Lentil Variety		3.19/lb		3.19	pounds
	tofu		1.69/10oz		0.169	pounds
	Meat alternative	Boca Burger	4.89/10oz		0.489	pounds
Nuts and nut butters	Nut or seed mixture	Roasted Peanuts	10.29/34.5oz		0.2982609	oz
	nut butter		5.89/16oz		0.368125	oz
Egg and egg mixtures	eggs		3.99/doz		3.99	doz
	egg substitute		4.59/16oz		0.286875	ounces
Whole milk products	Milk		6.59/gal		6.59	gal
Nonfat milk products	Milk		6.59/gal		6.59	gal
	yogurt		5.99/2lbs		0.1871875	oz
Cheese	Packaged cheese		4.59/8oz		0.57375	oz
Citrus, melon, berries (whole)	Melon	Watermelon	1.69/lb		1.69	pounds
	Yogurt		4.39/2lbs		0.1371875	oz
	Oranges		7.29/4lbs		1.8225	pounds
	Grapefruit		2.19ea		2.19	ea
	Lemon		0.99ea		0.99	ea
	Lime		0.99ea		0.99	ea
	Strawberries		8.99/lb		8.99	pounds
Other fruits	Bananas		1.39/lb		1.39	pounds
	Apples		6.49/3lb		2.1633333	pounds
	Grapes		5.69/lb		5.69	pounds
	Pineapple		1.79/lb		1.79	pounds
Fruit Juice	Grapefruit		7.29/60oz		0.1215	oz
	Apples		4.49/64oz		0.0701563	oz
Potatoes	Russet Potato		4.99/5lbs		0.998	pounds
	Asian Potato		2.89/lb		2.89	pounds
	Red/yellow potato		2.59/lb		2.59	pounds

Type	Subtype	Product	Price per	Price per unit	Cost	
Dark Green Veggies	Broccoli		4.29/lb	3.89/16oz	3.89	pounds
	Spinach		3.59/lb	2.75 fo 10oz	3.59	pounds
	Kale		3.99/bunch		3.99	pounds
Orange Veggies	Sweet Potato		2.39/lb		2.39	pounds
	Carrots		1.99/lb		1.99	pounds
	Pumpkin	Kabocha	2.59/lb		2.59	pounds
Other Veggies	Tomatoes		3.49/lb		3.49	pounds
	Corn		5.49/4 ears	3.09/16oz	3.09	pounds
	Onions		4.99/3lbs		1.6633333	pounds
	Peas			3.09/16oz		pounds
	Green Beans	String beans	3.99/8oz	3.09/16oz	3.09	pounds
	Celery		2.29/lb		2.29	pounds
	Cucumber		2.29/lb		2.29	pounds
	Zucchini		3.39/lb		3.39	pounds
	Mixed veggies			3.09/16oz	3.09	pounds
	Cauliflower		3.69/lb		3.69	pounds
	Mushrooms		7.29/lb		7.29	pounds
	Bell Pepper (Green)		3.49/lb		3.49	pounds
	Bell Pepper (Other)		5.99/lb		5.99	pounds
Whole grain bread, rice, pasta	Bread		4.29/20oz		0.2145	ounces
	Rice		14.99/20lbs		0.7495	pounds
	Pasta		3.79/12oz		5.0533333	pounds
	Tortilla or Wrap		3.99/16oz		0.249375	ounces
Whole Grain Cereals	Ready to Eat	Corn Flakes	5.89/24oz		0.2454167	ounces
	Hot Cereal		7.49/42oz		2.8533333	ounces
Popcorn and Whole Grain	Popcorn		3.49/3-3.3oz		0.3525253	ounces
	Crackers	Wheat Thins	4.99/9oz		0.5544444	ounces
None whole grain variety	Bread		4.29/20oz		0.2145	ounces
	Rice		14.99/20lbs		0.7495	pounds
	Pasta		3.19/lb		3.19	pounds
	Tortilla or Wrap		3.29/16oz		0.205625	ounces
	Ready to Eat	Grits	2.69/20oz		0.1345	ounces
	Hot Cereal		6.79/28oz		0.2425	ounces
	Crackers		4.49/16oz		0.280625	ounces

Table 19. Kokua Market Basket.

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Kokua	Unit
Beef, pork, veal, lamb	Beef	Frozen 90/10 Ground	7.49/lb		pounds	7.49
	Pork	Frozen Tenderloin	14.99/lb		pounds	14.99
Poultry	Chicken	Frozen Boneless Skinless	11.49/lb		pounds	11.49
	Turkey				pounds	
Fish	Canned tuna		2.79/5oz		ounces	0.558
	shellfish		18.99/lb		pounds	18.99
	white fish	Opah	21.99/lb		pounds	21.99
	tuna		21.99/lb		pounds	21.99
	salmon				pounds	
Packaged meats	Luncheon meat	Turkey	13.99/lb		pounds	13.99
Legumes, meat alternatives	Bean variety	Bulk Northern Beans/Canned Variety	2.39/lb	2.59/15oz	pounds	2.39
	Lentil Variety	Green lentils bulk	1.99/lb		pounds	1.99
	tofu		2.99/20oz		ounces	0.1495
	Meat alternative	Veggie Burger	5.69/6oz		ounces	0.9483333
Nuts and nut butters	Nut or seed mixture					
	nut butter	Fresh Peanut Butter	6.29/lb		ounces	0.393125
Egg and egg mixtures	eggs		5.79/doz		doz	5.79
	egg substitute	Vegan egg replacer sub	7.49/16oz		ounces	0.468125
Whole milk products	Milk		6.49/half gallon		gal	12.98
	Yogurt		6.89/32oz		ounces	0.2153125
Nonfat milk products	Milk		6.49/half gallon		gal	12.98
	yogurt		10.59/4lbs		ounces	0.1654688
Cheese	Packaged cheese	Cheddar	5.29/lb		ounces	0.330625
Citrus, melon, berries	Melon					
	Oranges		7.99/4lbs		pounds	1.9975
	Grapefruit		2.99/lb		pounds	2.99
	Lemon		3.99/lb		pounds	3.99
	Lime		3.99/lb		pounds	3.99
	Strawberries			4.79/15oz	pounds	5.1093333

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Kokua	Unit
Other fruits	Bananas		1.49/lb		pounds	1.4
	Apples	Red delicious	2.99/lb		pounds	2.9
	Grapes				pounds	
	Papaya		2.19/lb		pounds	2.1
	Pineapple		0.99/lb		pounds	0.9
Fruit Juice	Grapefruit					
	Apples	Cider	7.89/1.5L		ounces	0.1
Potatoes	Russet Potato		5.99/lb		pounds	5.9
	Asian Potato	Okinawan	2.99/lb		pounds	2.9
	Red/yellow potato		2.49/lb		pounds	2.4
Dark Green Veggies	Broccoli		3.69/lb	4.39/16oz	pounds	3.6
	Spinach			4.79/10oz	pounds	7.6
	Kale		3.99/lb		pounds	3.9
Orange Veggies	Sweet Potato		2.99/lb		pounds	2.9
	Carrots		8.49/5lbs		pounds	8.4
	Pumpkin		2.99/lb		pounds	2.9
Other Veggies	Tomatoes		3.99/lb		pounds	3.9
	Corn			4.29/10oz	pounds	6.8
	Onions		5.99/lb		pounds	5.9
	Peas				pounds	
	Green Beans		2.99/8oz		pounds	5.9
	Celery		3.79/lb		pounds	3.7
	Cucumber		1.99/lb		pounds	1.9
	Zucchini		3.99/lb		pounds	3.9
	Mixed veggies			3.99/16oz	pounds	3.9
	Cauliflower		4.49/lb		pounds	4.4
	Mushrooms		5.29/lb		pounds	5.2
	Bell Pepper (Green)		3.99/lb		pounds	3.9
	Bell Pepper (Other)		4.49/lb		pounds	4.4
Whole grain bread, rice,	Bread		4.29/20oz		ounces	0.2
	Rice		2.29/lb		pounds	2.2
	Pasta		3.39/16oz		pounds	3.3
	Tortilla or Wrap		3.76/16oz		ounces	0.2
Whole Grain Cereals	Ready to Eat		10.99/32oz		ounces	0.3
	Hot Cereal		1.39/lb		pounds	1.3
	Crackers		4.49/9.8oz		ounces	0.4
None whole grain variety	Bread		4.49/16oz		ounces	0.2
	Rice		3.79/lb		pounds	3.7
	Pasta		4.49/16oz		pounds	4.4
	Tortilla or Wrap		1.99/11oz		ounces	0.1
	Ready to Eat					
	Crackers		5.89/8.8oz			0.6

Table 20. Marukai Market Basket.

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Unit	Price
Beef, pork, veal, lamb	Beef	80%	4.99/lb		4.99	pounds
	Pork	Chop Center	3.59/lb		3.59	pounds
Poultry	Chicken	Boneless Skinless	5.69/lb		5.69	pounds
	Turkey					
Fish	Canned tuna		1.29/5oz		0.258	ounce
	shellfish			18.99/2lbs	9.495	pounds
	white fish			5.99/lb	5.99	pounds
	tuna		17.99/lb		17.99	pounds
	salmon		7.49/lb		7.49	pounds
Packaged meats	Luncheon meat	Chopped Ham	3.99/16oz		3.99	pounds
Legumes, meat alternatives	Bean variety		1.29/15oz	2.19/16oz	2.19	pounds
	Lentil Variety	Dried		2.39/16oz	2.39	pounds
	tofu		1.59/10oz		0.159	ounce
	Meat alternative					
Nuts and nut butters	Nut or seed mixture		3.39/12oz		0.2825	ounce
	nut butter		8.39/18oz		0.4661111	ounce
Egg and egg mixtures	eggs		2.99/doz		2.99	doz
	egg substitute					
Whole milk products	Milk		7.59/gal		7.59	gal
	Yogurt					
Nonfat milk products	Milk		7.59/gal		7.59	gal
	yogurt		1.47/5.3oz		0.2773585	ounce
Cheese	Packaged cheese		4.99/8oz		0.62375	ounce
Citrus, melon, berries (whole)	Melon					
	Oranges		1.69/lb		1.69	pounds
	Grapefruit		0.99 ea		0.99	ea
	Lemon		0.89 ea		0.89	ea
	Lime		1.59 ea		1.59	ea
	Strawberries					
Other fruits	Bananas		1.19/lb		1.19	pounds
	Apples		3.99/lb		3.99	pounds
	Grapes		4.99/lb		4.99	pounds
	Papaya		1.49/lb		1.49	pounds
	Pineapple		1.19 ea		1.19	ea
Fruit Juice	Grapefruit					
	Apples					
Potatoes	Russet Potato		2.69/5lbs		0.538	pounds
	Asian Potato		1.89/lb		1.89	pounds

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Unit	Price
Dark Green Veggies	Broccoli		2.99/lb	2.09/16oz	2.09	pounds
	Spinach		3.89/bunch		3.89	bu
	Kale		2.69/bunch		2.69	bu
Orange Veggies	Sweet Potato		2.29/lb		2.29	pounds
	Carrots		0.99/lb		0.99	pounds
	Pumpkin		1.88/lb		1.88	pounds
Other Veggies	Tomatoes		2.29/lb		2.29	pounds
	Corn		3.69/4 pack	2.09/16oz	2.09	pounds
	Onions		1.49/lb		1.49	pounds
	Peas			2.09/16oz	2.09	pounds
	Green Beans		1.99/8oz	2.09/16oz	2.09	pounds
	Celery		2.89/lb		2.89	pounds
	Cucumber		1.99/lb		1.99	pounds
	Zucchini		1.59/lb		1.59	pounds
	Mixed veggies			2.09/16oz	2.09	pounds
	Cauliflower					
	Mushrooms		3.25/6oz		8.6666667	pounds
	Bell Pepper (Green)		2.99/lb		2.99	pounds
	Bell Pepper (Other)	red	5.99/lb		5.99	pounds
Whole grain bread, rice, pasta	Bread		2.89/16oz		0.180625	ounces
	Rice		15.49/15lb		1.0326667	ounces
	Pasta		3.89/12oz		5.1866667	ounces
	Tortilla or Wrap					ounces
Whole Grain Cereals	Ready to Eat		2.79/14oz		0.1992857	ounces
	Hot Cereal		1.99/18oz		1.7688889	pounds
Popcorn and Whole Grain Snacks	Popcorn		2.69/8.25 oz (3 bags)		0.3260606	ounces
	Crackers		4.49/9.5oz		0.4726316	ounces
None whole grain variety	Bread		2.89/16oz		0.180625	ounces
	Rice		15.49/15lbs		1.0326667	pounds
	Pasta					
	Tortilla or Wrap					
	Ready to Eat		4.49/12oz		0.3741667	ounces
	Hot Cereal	Grits	2.29/20oz		0.1145	ounces
	Crackers		3.79/6oz		0.6316667	ounces

Table 21. Nijiya Market Basket.

Type	Subtype	Product	Price per unit	Cost	Unit
Beef, pork, veal, lamb	Beef				
	Pork	Loin	10.99	10.9	pounds
Poultry	Chicken	Boneless Skinless	12.99	12.9	pounds
	Turkey				
Fish	Canned tuna		4.99/240g	0.589834	ounces
	shellfish				
	white fish				
	tuna				
	salmon	Fresh Sashimi	16.99/lb	16.9	pounds
Packaged meats	Luncheon meat				
Legumes, meat alternatives	Bean variety	Canned pinto/kidney	2.99/15oz	3.189333	pounds
	Lentil Variety	Canned	2.99/15oz	3.189333	pounds
	tofu				
	Meat alternative				
Nuts and nut butters	Nut or seed mixture				
	nut butter				
Egg and egg mixtures	eggs		5.29/doz	5.2	doz
	egg substitute				
Whole milk products	Milk		5.99/half gallon	11.9	gal
	Yogurt				
Nonfat milk products	Milk		5.99/half gal	11.9	gal
	yogurt		1.09/6oz	0.181666	ounces
Cheese	Packaged cheese		4.49/8oz	0.748333	ounces
Citrus, melon, berries	Melon	Cantaloupe	2.29/lb	2.2	pounds
	Oranges		1.89/lb	1.8	pounds
	Grapefruit		2.59/lb	2.5	pounds
	Lemon		0.79 ea	0.7	each
	Lime		2.99/2 ct	1.49	each
	Strawberries				
Other fruits	Bananas		1.99/lb	1.9	pounds
	Apples		1.39/lb	1.3	pounds
	Grapes				
	Papaya				
	Pineapple		1.29/lb	1.2	pounds
Fruit Juice	Grapefruit				
	Apples				

Type	Subtype	Product	Price per unit	Cost	Unit
Potatoes	Russet Potato		1.79/lb	1.79	pounds
	Asian Potato		2.79/lb	2.79	pounds
	Red/yellow potato		1.19/lb	1.19	pounds
Dark Green Veggies	Broccoli		3.59/lb	3.59	pounds
	Spinach		3.59/bunch	3.59	bunch
	Kale				
Orange Veggies	Sweet Potato		2.99/lb	2.99	pounds
	Carrots		1.74/lb	1.74	pounds
	Pumpkin		2.79/lb	2.79	pounds
Other Veggies	Tomatoes		2.99/lb	2.99	pounds
	Corn				
	Onions		1.09/lb	1.09	pounds
	Peas				
	Green Beans				
	Celery		2.99/lb	2.99	pounds
	Cucumber		4.99/pack of 3	4.99	pounds
	Zucchini				
	Mixed veggies				
	Cauliflower		6.99/lb	6.99	pounds
	Mushrooms		3.99/8 oz	7.98	pounds
	Bell Pepper (Green)		2.59/lb	2.59	pounds
	Bell Pepper (Other)	red	3.29/lb	3.29	pounds
Whole grain bread, rice, pasta	Bread		3.99/43oz	0.0927907	ounces
	Rice		29.99/15lbs	1.9993333	pounds
	Pasta				
	Tortilla or Wrap				
Whole Grain Cereals	Ready to Eat				
	Hot Cereal				
Popcorn and Whole Grain Sn	Popcorn				
	Crackers				
None whole grain variety	Bread		3.79/43oz	0.0881395	ounces
	Rice		29.99/15lbs	1.9993333	pounds
	Pasta				
	Tortilla or Wrap				
	Ready to Eat				
	Hot Cereal				
	Crackers				

Table 22. Pacific Supermarket Market Basket.

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	price	
Beef, pork, veal, lamb	Beef	Regular Ground	3.49/lb	2.79/lb	2.7	pounds
	Pork	Loin	3.79/lb		3.7	pounds
Poultry	Chicken	Boneless Skinless	2.99/lb		2.9	pounds
	Turkey					pounds
Fish	Canned tuna		1.49/5oz		0.29	pounds
	shellfish	Shrimp/Scallop	4.99/lb	5.99/12oz	4.9	pounds
	white fish	Tilapia/Tang	3.99/lb	3.99/lb	3.9	pounds
	tuna					pounds
	salmon		5.99/lb		5.9	pounds
Packaged meats	Luncheon meat					pounds
Legumes, meat alternatives	Bean variety	Variety/Pinto	1.49/15oz	2.29/lb	2.2	pounds
	Lentil Variety					pounds
	tofu		1.69/14oz		0.120714	ounces
	Meat alternative					
Nuts and nut butters	Nut or seed mixture	Dried Peanut	1.79/12oz		0.149166	ounces
	nut butter		3.99/16oz		0.24937	ounces
Egg and egg mixtures	eggs		10.99/2.5doz		4.39	doz
	egg substitute					
Whole milk products	Milk		5.79/gal		5.7	gal
	Yogurt		3.99/32oz		0.124687	ounces
Nonfat milk products	Milk		5.49/gal		5.4	gal
	yogurt		2.99/32oz		0.093437	ounces
Cheese	Packaged cheese		5.99/16oz		0.37437	ounces
Citrus, melon, berries (whole)	Melon	honeydew	1.59		1.5	pounds
	Oranges		1.49		1.4	pounds
	Grapefruit		1.19		1.1	pounds
	Lemon		1.59/3pk		0.5	ea
	Lime		1.79/3pk		0.596666	ea
	Strawberries		6.99/lb	3.99/16oz	3.9	pounds
Other fruits	Bananas		1.19	13.99/4lbs	1.1	pounds
	Apples		1.29		1.2	pounds
	Grapes		4.99		4.9	pounds
	Papaya		1.29		1.2	pounds
	Pineapple		1.19		1.1	pounds
Fruit Juice	Grapefruit					
	Apples					
Potatoes	Russet Potato		2.99/5lbs		0.59	pounds
	Asian Potato		2.49/lb		2.4	pounds

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	price	
	Red/yellow potato		1.39/lb		1.3	pounds
Dark Green Veggies	Broccoli		3.49	2.79/lb	2.7	pounds
	Spinach		1.89/bu		1.8	bunch
	Kale		2.49/bu		2.4	bunch
Orange Veggies	Sweet Potato		1.99/lb		1.9	pounds
	Carrots		1.19		1.1	pounds
	Pumpkin		1.19		1.1	pounds
Other Veggies	Tomatoes		2.49		2.4	pounds
	Corn		3.99/4pk	1.99/4pk	0.497	ea
	Onions		0.99		0.9	pounds
	Peas			2.19/lb	2.1	pounds
	Green Beans		1.79/4oz	2.19/lb	2.1	pounds
	Celery		1.69/lb		1.6	pounds
	Cucumber		2.49		2.4	pounds
	Zucchini		2.49		2.4	pounds
	Mixed veggies			2.19/lb	2.1	pounds
	Cauliflower		3.49		3.4	pounds
	Mushrooms		3.49/8oz		6.9	pounds
	Bell Pepper (Green)		2.49		2.4	pounds
	Bell Pepper (Other)	red	3.99		3.9	pounds
Whole grain bread, rice, pasta	Bread		2.69/16oz		0.16812	ounces
	Rice		15.99/15lbs		1.06	pounds
	Pasta		1.49/16oz		1.4	pounds
	Tortilla or Wrap					
Whole Grain Cereals	Ready to Eat		3.29/14oz		0.23	ounces
	Hot Cereal		4.99/42oz		1.900952	ounces
Popcorn and Whole Grain	Popcorn		2.49/3pk (3*3.3oz)		0.251515	ounces
	Crackers					ounces
None whole grain variety	Bread		2.69/16oz		0.16812	ounces
	Rice		39.99/50lbs		0.799	pounds
	Pasta		1.29/16oz		1.2	pounds
	Tortilla or Wrap					
	Ready to Eat		5.99/28oz		0.213928	ounces
	Hot Cereal		4.29/12oz		0.357	ounces
	Crackers		6.49/30oz		0.216333	ounces

Table 23. Palama Supermarket Market Basket

Type	Subtype	Product	Price per unit	Unit Price	Unit
Beef, pork, veal, lamb	Beef	Ground Beef-Unknown Percentage	8.99-lb	8.99	pound
	Pork	Ground - Percentage Unknown	4.99/lb	4.99	pound
Poultry	Chicken				Pound
	Turkey				Pound
Fish	Canned tuna				Pound
	shellfish				Pound
	white fish	Frozen Pollack	2.39/lb	2.39	Pound
	tuna				Pound
	salmon				Pound
Packaged meats	Luncheon meat				Pound
Legumes, meat alternatives	Bean variety	Dried Black bean	14.99/5lbs	2.998	Pound
	Lentil Variety				Pound
	tofu		1.49/10oz	0.149	Ounce
	Meat alternative				Ounce
Nuts and nut butters	Nut or seed mixture				Ounce
	nut butter				Ounce
Egg and egg mixtures	eggs		5.49/doz		Dozen
	egg substitute				Ounce
Whole milk products	Milk				Gallon
	Yogurt				Ounce
Nonfat milk products	Milk				Gallon
	yogurt				Ounce
Cheese	Packaged cheese				Ounce
Citrus, melon, berries (whole	Melon				
	Oranges		1.29/lb	1.29	Pound
	Grapefruit				
	Lemon		0.69	0.69	Each
	Lime				
	Strawberries				
Other fruits	Bananas		1.39/lb	1.39	Pounds
	Apples	Fuji	1.59/lb	1.59	Pounds
	Grapes				
	Papaya				
	Pineapple				

Type	Subtype	Product	Price per unit	Unit Price	Unit
Fruit Juice	Grapefruit				
	Apples				
Potatoes	Russet Potato		0.69/lb	0.69	Pounds
	Asian Potato		2.89/lb	2.89	Pounds
	Red/yellow potato	Mini packaged potatoes	5.99/lb	5.99	Pounds
Dark Green Veggies	Broccoli		2.99/lb	2.99	Pounds
	Spinach		2.99/bunch	2.99	Bunch
	Kale				
Orange Veggies	Sweet Potato		1.99/lb	1.99	Pounds
	Carrots		1.09/lb	1.09	Pounds
	Pumpkin	Kabocha	1.39/lb	1.39	Pounds
Other Veggies	Tomatoes		2.29/lb	2.29	Pounds
	Corn		2.99/3 ears	0.9966667	Each
	Onions		0.89/lb	0.89	Pounds
	Peas				
	Green Beans				
	Celery		2.59/lb	2.59	Pounds
	Cucumber		2.29/lb	2.29	Pounds
	Zucchini		2.39/lb	2.39	Pounds
	Mixed veggies				
	Cauliflower				
	Mushrooms		1.99/4 oz	7.96	Pounds
	Bell Pepper (Green)		1.99/lb	1.99	Pounds
	Bell Pepper (Other)	Red	3.99/lb	3.99	Pounds
Whole grain bread, rice, past	Bread				
	Rice		5.99/5lbs	1.198	Pounds
	Pasta				
Whole Grain Cereals	Ready to Eat				
	Hot Cereal				
Popcorn and Whole Grain Sn	Popcorn				
None whole grain variety	Bread				
	Rice		5.99/5lbs	1.198	Pounds
	Pasta				
	Tortilla or Wrap				
	Ready to Eat				
	Crackers	Saltine	1.49/56g	0.7544304	Ounce

Table 24. Safeway Market Basket.

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Price	unit
Beef, pork, veal, lamb	Beef		6.99		6.99	pounds
	Pork		3.99/lb		3.99	pounds
Poultry	Chicken		3.99		3.99	pounds
	Turkey		5.99		5.99	pounds
Fish	Canned tuna		1.29/5oz		0.258	ounces
	shellfish	Shrimp	13.99		13.99	pounds
	white fish		4.41		4.41	pounds
	tuna		10.99		10.99	
	salmon		10.99		10.99	pound
Packaged meats	Luncheon meat				8.88	pound
Legumes, meat alternatives	Bean variety		1.99		1.99	pound
	Lentil Variety		1.99		1.99	pound
	tofu				0.208	ounces
	Meat alternative				0.375	ounces
Nuts and nut butters	Nut or seed mixture				0.25	ounces
	nut butter				0.308	ounces
Egg and egg mixtures	eggs		3.99/doz		3.99	doz
	egg substitute				0.172	ounces
Whole milk products	Milk		4.99/gal		4.99	gal
	Yogurt		4.49/32oz		0.1403125	oz
Nonfat milk products	Milk		5.68/gal		5.68	gal
	yogurt		3.99/32oz		0.1246875	ounces
Cheese	Packaged cheese		9.99/32oz		0.3121875	ounces
Citrus, melon, berries (whole)	Melon		1.99		1.99	pounds
	Oranges		8.99/8lbs		1.12375	pounds
	Grapefruit		4.99/5lbs		0.998	pounds
	Lemon		4.99/2lbs		2.495	pounds
	Lime		1.49		1.49	ea
	Strawberries		3.99/lb		3.99	pounds
Other fruits	Bananas		1.19		1.19	pounds
	Apples		4.99/3lbs		1.6633333	pounds
	Grapes		4.99/lb		4.99	pounds
	Papaya		149/lb		1.49	pounds
	Pineapple		1.29/lb		1.29	pounds
Fruit Juice	Grapefruit		4.49/64oz		0.0701563	oz
	Apples		6.49/gal		0.0507031	oz
Potatoes	Russet Potato		8.99/15lbs		0.5993333	pounds
	Asian Potato		1.99		1.99	pounds

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Price	unit
Dark Green Veggies	Broccoli		3.49/lb	3.00/20oz	2.4	pounds
	Spinach		4.99/16oz	3.49/2lbs	1.74	pounds
	Kale		5.49/24oz	3.00/10oz	3.6	pounds
Orange Veggies	Sweet Potato		2.49/lb		2.4	pounds
	Carrots		5.99/5lbs	3.00/24oz	1.19	pounds
	Pumpkin			2.5/14oz	2.857142	pounds
Other Veggies	Tomatoes		2.99		2.9	pounds
	Corn		5.99/4pk	6.00/4lbs	1.5	pounds
	Onions		2.49/3lbs		0.8	pounds
	Peas			6.00/4lbs	1.5	pounds
	Green Beans			2.50/lb	2.5	pounds
	Celery		2.49/bunch		2.4	bunch
	Cucumber		1.49/lb		1.4	pounds
	Zucchini		3.49/lb		3.4	pounds
	Mixed veggies			3.49/2lbs	1.74	pounds
	Cauliflower		3.49/ea	3.00/20oz	2.4	pounds
	Mushrooms		5.99/lb		5.9	pounds
	Bell Pepper (Green)		1.99/lb		1.9	pounds
	Bell Pepper (Other)		3.99/lb		3.9	pounds
Whole grain bread, rice, pasta	Bread		3.99/20oz		0.199	ounces
	Rice		12.99/20lbs		0.649	pounds
	Pasta		2.69/13oz		3.310769	pounds
	Tortilla or Wrap		3.99/23.5oz		0.169787	ounces
Whole Grain Cereals	Ready to Eat		3.99/16.4oz		0.243292	ounces
	Hot Cereal		3.49/40oz		1.39	pounds
Popcorn and Whole Grain Snacks	Popcorn		2.99/3pk-9oz ea		0.332222	ounces
	Crackers		2.39/10oz		0.23	ounces
None whole grain variety	Bread		3.99/20oz		0.199	ounces
	Rice		11.79/20lbs		0.589	pounds
	Pasta		2.19/16oz		0.13687	pounds
	Tortilla or Wrap		2.99/14oz		0.213571	ounces
	Ready to Eat		3.49/12.8oz		0.272656	ounces
	Hot Cereal		5.69/40oz		0.1422	ounces
	Crackers		2.69/15.1		0.178145	ounces

Table 25. Sam's Club Market Basket

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Price	unit
Beef, pork, veal, lamb	Beef	90%	3.78/lb		3.7	pounds
	Pork	Loin	2.98		2.9	pounds
Poultry	Chicken		2.18	15.38/6lbs	2.1	pounds
	Turkey		2.79		2.7	pounds
Fish	Canned tuna		10.74/10-5oz can		0.214	pounds
	shellfish	Shrimp	9.99/lb	16.98/2lbs	8.4	pounds
	white fish	Mahi/Tilapia	11.99/lb	11.86/3lbs	3.953333	pounds
	tuna		12.99	14.98/2lbs	7.4	pounds
	salmon		7.99	9.25/2lbs	4.6	pounds
Packaged meats	Luncheon meat	Oscar Mever Turkey	7.26/2lbs		3.6	pounds
Legumes, meat alternatives	Bean variety	Kidney beans/pinto beans	6.48/8-15oz can	14.48/25lbs	0.05	pounds
	Lentil Variety					
	tofu		3.98/2-19oz		0.104736	ounces
	Meat alternative					
Nuts and nut butters	Nut or seed mixture	Dried peanuts	7.69/52oz		0.147884	ounces
	nut butter		9.78/24oz		0.407	ounces
Egg and egg mixtures	eggs		3.48/doz		3.4	doz
	egg substitute		10.48/4*16oz		0.1637	ounces
Whole milk products	Milk		4.28/gal		4.2	gal
	Yogurt		7.28/48oz		0.151666	ounces
Nonfat milk products	Milk		3.95/gal		3.9	gal
	yogurt		10.95/12*5.3oz		0.172169	ounces
Cheese	Packaged cheese		10.49/5lbs		0.13112	ounces
Citrus, melon, berries (whole)	Melon					
	Oranges		9.98/10lbs		0.99	pounds
	Grapefruit		7.89/8lbs		0.9862	pounds
	Lemon		4.79/3lbs		1.596666	pounds
	Lime		3.88/3lbs		1.293333	pounds
	Strawberries		8.87/2lbs	10.38/5lbs	2.07	pounds
Other fruits	Bananas		1.89/3lbs		0.6	pounds
	Apples		8.92/6lbs		1.486666	pounds
	Grapes		8.87/3lbs		2.956666	pounds
	Papaya		6.88/5lbs		1.37	pounds
	Pineapple		2.98/ea		2.9	each
Fruit Juice	Grapefruit					
	Apples		4.98/2 pack 96oz		0.025937	ounces

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	Price	unit
Potatoes	Russet Potato		8.86/15lbs		0.590666	pounds
	Asian Potato		14.98/5lbs		2.99	pounds
	Red/yellow potato		7.88/10lbs		0.78	pounds
Dark Green Veggies	Broccoli		3.98/2lbs	6.98/4lbs	1.74	pounds
	Spinach		4.48/lb		4.4	pounds
	Kale		4.47/lb		4.4	pounds
Orange Veggies	Sweet Potato		11.38/10lbs		1.13	pounds
	Carrots		4.28/5lbs		0.85	pounds
	Pumpkin					pounds
Other Veggies	Tomatoes		5.98/2lbs		2.9	pounds
	Corn			6.78/4lbs	1.69	pounds
	Onions		7.28/10lbs		0.72	pounds
	Peas			6.58/5lbs	1.31	pounds
	Green Beans		5.98/2lbs		2.9	pounds
	Celery		2.98/3 hearts		0.993333	hearts
	Cucumber		4.93/2lbs		2.46	pounds
	Zucchini		7.88/4lbs		1.9	pounds
	Mixed veggies			6.82/6*12oz	1.515555	pounds
	Cauliflower					
	Mushrooms		2.87/16oz		2.8	pounds
	Bell Pepper (Green)		3.98/6 count		0.648333	each
	Bell Pepper (Other)		7.82/1200grams-6 count		2.950943	pounds
Whole grain bread, rice, pasta	Bread		7.14/2 pack - 64oz		0.111562	ounces
	Rice		8.78/15lbs		0.585333	pounds
	Pasta		6.28/4*13.25		1.886792	pounds
	Tortilla or Wrap		7.98/3lbs		0.16437	ounces
Whole Grain Cereals	Ready to Eat	Special K	7.98/38oz		0.2	ounces
	Hot Cereal		8.27/10 lbs		0.82	pounds
Popcorn and Whole Grain Snacks	Popcorn		7.98/30 count		0.080606	ounces
	Crackers		8.48/20oz		0.42	ounces
None whole grain variety	Bread		4.98/2*24oz		0.1037	ounces
	Rice		17.73/50lbs		0.354	pounds
	Pasta		7.36/6lbs		1.226666	pounds
	Tortilla or Wrap	Cocoa puffs	6.18/36oz		0.171666	ounces
	Ready to Eat					
	Crackers	Keebler club	6.68/41.1oz		0.160583	ounces

Table 26. Seafood City Market Basket

Type	Subtype	Product	Price per unit	Unit Price	Unit
Beef, pork, veal, lamb	Beef	80/20	3.99	3.99	pounds
	Pork		4.99	4.99	
Poultry	Chicken		3.99	3.99	
	Turkey				
Fish	Canned tuna		1.59/5oz	0.318	
	shellfish		5.99/lb	5.99	
	white fish		3.99/lb	3.99	
	tuna		11.99/lb	11.99	
	salmon		6.99/lb	6.99	
Packaged meats	Luncheon meat				
Legumes, meat alternatives	Bean variety	can	1.29/15oz		
	Lentil Variety				
	tofu		1.99/14oz	0.1421429	
	Meat alternative		3.99/8oz	0.49875	
Nuts and nut butters	Nut or seed mixture		4.99/lb	0.311875	
	nut butter				
Egg and egg mixtures	eggs		3.29/doz	3.29	
	egg substitute				
Whole milk products	Milk		5.99	5.99	gal
	Yogurt				
Nonfat milk products	Milk		5.49	5.49	gal
	yogurt				
Cheese	Packaged cheese				
Citrus, melon, berries (whole)	Melon	cantaloupe	1.59	1.59	pounds
	Oranges		0.99	0.99	
	Grapefruit				
	Lemon		0.79	3.95	
	Lime		0.79	3.95	
	Strawberries	4.99	3.59	3.59	pounds
Other fruits	Bananas		0.99	0.99	
	Apples		1.49	1.49	
	Grapes		2.99	2.99	
	Papaya		1.49	1.49	
	Pineapple		0.79	0.79	
Fruit Juice	Grapefruit		1.99/64oz	0.0310938	ounces
	Apples				
Potatoes	Russet Potato		2.99/5#	0.598	
	Asian Potato	ube		2.59	
	Red/yellow potato			1.59	

Type	Subtype	Product	Price per unit	Unit Price	Unit
Dark Green Veggies	Broccoli			2.79	
	Spinach			2.704	
	Kale			2.59	
Orange Veggies	Sweet Potato			1.99	
	Carrots			1.29	
	Pumpkin			1.59	
Other Veggies	Tomatoes			2.59	
	Corn	4.59/4ears	2.39/12oz	3.1866667	
	Onions			0.99	
	Peas			3.184	
	Green Beans			2.79/lb	
	Celery			1.99	
	Cucumber			1.59	
	Zucchini			1.99	
	Mixed veggies		2.39/10oz	3.824	
	Cauliflower			1.99	
	Mushrooms		3.29/8oz	6.58	
	Bell Pepper (Green)			2.49	
	Bell Pepper (Other)			3.49	
Whole grain bread, rice, pasta	Bread		3.59/22oz	0.1631818	
	Rice		14.99/15#	0.9993333	
	Pasta		2.49/12oz	3.32	
	Tortilla or Wrap				
Whole Grain Cereals	Ready to Eat		2.29/14oz	0.1635714	
	Hot Cereal		4.99/42oz	1.9009524	
Popcorn and Whole Grain Snacks	Popcorn				
	Crackers				
None whole grain variety	Bread				
	Rice		14.99/15#	0.9993333	
	Pasta		0.49/7oz	1.12	
	Tortilla or Wrap				
	Ready to Eat		4.29/28oz	0.1532143	
	Hot Cereal				
	Crackers		3.99/16oz	0.249375	

Table 27. Tamura's Market Basket.

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	price	unit
Beef, pork, veal, lamb	Beef	93%	5.89/lb		5.89	pounds
	Pork	Loin	4.99/lb		4.99	pounds
Poultry	Chicken		5.39/lb		5.39	pounds
	Turkey		5.99/lb		5.99	pounds
Fish	Canned tuna		1.29/5oz		0.25	pounds
	shellfish	Frozen Shrimp	13.99/2lbs		6.99	pounds
	white fish	Tilapia	8.49/2lbs		4.24	pounds
	tuna					
	salmon					
Packaged meats	Luncheon meat	Variety	3.99/9oz		7.093333	pounds
Legumes, meat alternatives	Bean variety		2.29/15oz		2.442666	pounds
	Lentil Variety		2.19/16oz		2.19	
	tofu		1.69/14oz		0.120714	ounces
	Meat alternative					
Nuts and nut butters	Nut or seed mixture	Peanuts	4.29/16oz		0.26812	ounces
	nut butter		3.79/16oz		0.23687	ounces
Egg and egg mixtures	eggs		10.99/30count		4.39	doz
	egg substitute		4.19/16oz		0.26187	ounces
Whole milk products	Milk		5.99/gal		5.99	gal
	Yogurt		4.99/32oz		0.155937	ounces
Nonfat milk products	Milk		5.99/gal		5.99	gal
	yogurt		3.39/2lbs		0.105937	ounces
Cheese	Packaged cheese		6.29/16oz		0.39312	ounces
Citrus, melon, berries (whole)	Melon	Cantaloupe	0.89/lb		0.89	pounds
	Oranges		4.99/4lbs		1.247	pounds
	Grapefruit		1.79ea		1.79	ea
	Lemon		0.99 ea		0.99	ea
	Lime		0.89 ea		0.89	ea
	Strawberries			3.39/16oz	3.39	pounds
Other fruits	Bananas		1.29/lb		1.29	pounds
	Apples		4.36/3lbs		4.36	pounds
	Grapes		3.79/lb		3.79	pounds
	Papaya					pounds
	Pineapple		2.59 ea		2.59	pounds
Fruit Juice	Grapefruit		6.59/60oz		0.109833	ounces
	Apples		3.99/64oz		0.062343	ounces
Potatoes	Russet Potato		2.49/5 lbs		0.49	pounds
	Asian Potato		2.59		2.59	pounds

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	price	unit
Dark Green Veggies	Broccoli		3.19	2.19/16oz	2.19	pounds
	Spinach			2.89/16oz	2.89	pounds
	Kale		2.99/bag		2.99	bag
Orange Veggies	Sweet Potato		1.89		1.89	pounds
	Carrots		1.29		1.29	pounds
	Pumpkin		1.69		1.69	pounds
Other Veggies	Tomatoes		1.99	10.99/2040g	1.99	pounds
	Corn		3.89/5 pk		0.778	ea
	Onions		0.99		0.99	pounds
	Peas			2.19/lb	2.19	pounds
	Green Beans		2.69/8oz	2.19/16oz	2.19	pounds
	Celery		1.89/lb		1.89	pounds
	Cucumber		2.19		2.19	pounds
	Zucchini		1.89		1.89	pounds
	Mixed veggies			2.19/16oz	2.19	pounds
	Cauliflower		3.99/lb		3.99	pounds
	Mushrooms		2.79/8oz		5.58	pounds
	Bell Pepper (Green)		2.19/lb		2.19	pounds
	Bell Pepper (Other)		5.89/lb		5.89	pounds
Whole grain bread, rice, pasta	Bread		2.99/16oz		0.186875	ounces
	Rice		10.99/15lbs		0.7326667	pounds
	Pasta		3.69/16oz		3.69	pounds
	Tortilla or Wrap		3.39/16oz		0.211875	ounces
Whole Grain Cereals	Ready to Eat		4.39/18oz		0.2438889	ounces
	Hot Cereal		4.99/42oz		1.9009524	pounds
Popcorn and Whole Grain Snacks	Popcorn		2.79/3 pk		0.2818182	ounces
	Crackers		3.99/9.5		0.42	ounces
None whole grain variety	Bread		2.99/16oz		0.186875	ounces
	Rice		33.99/50lbs		0.6798	pounds
	Pasta		1.79/16oz		1.79	pounds
	Tortilla or Wrap		4.19/28oz		0.1496429	ounces
	Ready to Eat		5.99/28oz		0.2139286	ounces
	Hot Cereal		2.29/20oz		0.1145	ounces
	Crackers		3.79/16oz		0.236875	ounces

Table 28. Times Market Basket.

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	price	Unit
Beef, pork, veal, lamb	Beef	91/10	6.49/lb		6.49	pounds
	Pork		3.99/lb		3.99	pounds
Poultry	Chicken		5.49/lb		5.49	pounds
	Turkey	Ground	5.29/lb	2.49/lb	2.49	pounds
Fish	Canned tuna		1.69/5oz		0.338	ounces
	shellfish	Shrimp	23.49/4lbs		5.8725	pounds
	white fish	Marlin	4.99/lb		4.99	pounds
	tuna		8.99/lb		8.99	pounds
	salmon		7.99/lb		7.99	pounds
Packaged meats	Luncheon meat	Foster Farm Variety	3.99/9oz		7.0933333	pounds
Legumes, meat alternatives	Bean variety		2.29/15oz	2.29/16oz	2.29	pounds
	Lentil Variety			3.49/lb	3.49	pounds
	tofu		2.39/14oz		0.1707143	ounces
	Meat alternative	Boca Burgers	4.99/10oz		0.499	ounces
Nuts and nut butters	Nut or seed mixture	Peanuts	4.99/12oz		0.4158333	ounces
	nut butter	PB	4.29/16oz		0.268125	ounces
Egg and egg mixtures	eggs		3.69/doz		3.69	doz
	egg substitute		6.99/32oz		0.2184375	ounces
Whole milk products	Milk		6.99/gal		6.99	gal
	Yogurt		3.99/32oz		0.1246875	ounces
Nonfat milk products	Milk		6.99/gal		6.99	gal
	yogurt		3.99/32oz		0.1246875	ounces
Cheese	Packaged cheese		10.99/32oz		0.3434375	ounces
Citrus, melon, berries (whole)	Melon	Cantaloupe	1.69/lb		1.69	pounds
	Oranges		1.79/lb		1.79	pounds
	Grapefruit		1.89 ea		1.89	ea
	Lemon		0.99 ea		0.99	ea
	Lime		0.99 ea		0.99	ea
	Strawberries		7.99/16oz	3.78/12oz	5.04	pounds
Other fruits	Bananas		1.19/lb		1.19	pounds
	Apples		1.99/lb		1.99	pounds
	Grapes		3.69/lb		3.69	pounds
	Papaya		1.69/lb		1.69	pounds
	Pineapple		1.29/lb		1.29	pounds
Fruit Juice	Grapefruit		5.09/64oz		0.0795313	ounces
	Apples		3.99/64oz		0.0623438	ounces
Potatoes	Russet Potato		2.99/5lbs		0.598	pounds
	Asian Potato		2.69/lb		2.69	pounds

Type	Subtype	Product	Price per unit	Price per unit (Frozen)	price	unit
Dark Green Veggies	Broccoli		2.69	2.50/14oz	2.6	pounds
	Spinach		5.28/5oz	2.50/16oz	2.5	pounds
	Kale		2.79/12oz		3.7	pounds
Orange Veggies	Sweet Potato		2.69/lb		2.6	pounds
	Carrots		1.39/lb		1.3	pounds
	Pumpkin		2.39/lb	1.58/12oz	2.3	pounds
Other Veggies	Tomatoes		2.99/lb		2.9	pounds
	Corn		0.79 ea	3.98/32oz	1.9	pounds
	Onions		1.79/lb	2.50/14oz	1.7	pounds
	Peas			1.5/16oz	1.5	pounds
	Green Beans		3.69/12oz	2.50/14oz	2.857142	pounds
	Celery		1.79/lb		1.7	pounds
	Cucumber		1.69/lb		1.6	pounds
	Zucchini		2.59/lb		2.5	pounds
	Mixed veggies			1.98/12oz	2.6	pounds
	Cauliflower		2.89/lb	3.79/16oz	2.8	pounds
	Mushrooms		5/lb		5	pounds
	Bell Pepper (Green)		2.69/lb		2.6	pounds
	Bell Pepper (Other)		3.99/lb	3.89/14oz	3.9	pounds
Whole grain bread, rice, pasta	Bread		3.99/12oz		3.9	ounces
	Rice		14.99/15		0.999333	pounds
	Pasta		3.19/lb		3.1	pounds
	Tortilla or Wrap		3.99/17.6oz		0.226704	ounces
Whole Grain Cereals	Ready to Eat		4.98/18oz		0.276666	ounces
	Hot Cereal		4.99/42oz		1.900952	pounds
Popcorn and Whole Grain Snacks	Popcorn		2.99/3bag (2.9oz		0.343678	ounces
	Crackers		5.59/16oz		0.34937	ounces
None whole grain variety	Bread		3.99/22oz		0.181363	ounces
	Rice		14.99/15		0.999333	pounds
	Pasta		3.39/32oz		1.69	pounds
	Tortilla or Wrap		3.99/17.6oz		0.226704	ounces
	Ready to Eat		4.18/13.5oz		0.309629	ounces
	Hot Cereal		2.9/20oz		0.14	ounces
	Crackers		3.59/16oz		0.22437	ounces

Table 29. WholeFoods Market Basket.

Type	Subtype	Product	Price per unit	Price per unit	Price	unit
Beef, pork, veal, lamb	Beef	93%	8.99/lb		8.99	poun
	Pork	Loin	6.99/lb		6.99	poun
Poultry	Chicken	Boneless Skinless	6.99/lb		6.99	poun
	Turkey	93%	7.99/lb		7.99	poun
Fish	Canned tuna		1.99/5oz		0.398	ounce
	shellfish	Shrimp (cooked & raw)	15.99	17.99/lb	15.99	poun
	white fish	Tilapia/Turbot	10.99/lb	12.99/12oz	10.99	poun
	tuna		11.99/lb	10.99/12oz	10.99	poun
	salmon		12.99/lb		12.99	poun
Packaged meats	Luncheon meat	Lean ham	4.99/7oz		11.405714	poun
Legumes, meat alternatives	Bean variety		0.79/15oz	2.99/lb	2.99	poun
	Lentil Variety	Canned & dried	2.69/15oz	3.79/lb	3.79	poun
	tofu		1.99/14oz		0.1421429	ounce
	Meat alternative	Boca Meatless	3.99/5oz	5.99/12oz	0.4991667	ounce
Nuts and nut butters	Nut or seed mixture	Peanuts	4.49/16oz		0.280625	ounce
	nut butter	PB	6.99/36oz		0.1941667	ounce
Egg and egg mixtures	eggs		4.69/doz		4.69	doz
	egg substitute		4.69/16oz		0.293125	ounce
Whole milk products	Milk		7.99/gal		7.99	gal
	Yogurt		4.69/2lbs		0.1465625	ounce
Nonfat milk products	Milk		7.99/gal		7.99	gal
	yogurt		4.69/32oz		0.1465625	ounce
Cheese	Packaged cheese		5.29/12oz		0.4408333	ounce
Citrus, melon, berries (whole)	Melon					
	Oranges		0.99/lb		0.99	poun
	Grapefruit		1.79/lb		1.79	poun
	Lemon		2.99/lb		2.99	poun
	Lime		3.99/lb		3.99	poun
	Strawberries		6.99/lb		6.99	poun
Other fruits	Bananas		1.19/lb		1.19	poun
	Apples		2.29/lb		2.29	poun
	Grapes		4.49/lb		4.49	poun
	Papaya		1.99/lb		1.99	poun
	Pineapple		7.99/lb		7.99	poun
Fruit Juice	Grapefruit		5.99/33.8oz		0.1772189	ounce
	Apples		9.99/gal		0.0780469	ounce

Potatoes	Russet Potato		6.99/5lbs		1.398	poun
	Asian Potato		2.99/lb		2.99	poun

Type	**Subtype**	**Product**	**Price per unit**	**Price per unit (Frozen)**	**Price**	**unit**
	Red/yellow potato		6.99		6.99	pounds
Dark Green Veggies	Broccoli		3.99	2.99/16oz	2.99	pounds
	Spinach		7.99		7.99	pounds
	Kale		3.99/bunch		3.99	bunch
Orange Veggies	Sweet Potato		3.49/3lbs		1.1633333	pounds
	Carrots		5.99/5lbs		1.198	pounds
	Pumpkin	Kabocha	2.29/lb		2.29	pounds
Other Veggies	Tomatoes		2.99		2.99	pounds
	Corn		1.99/ea	3.99/32oz	1.995	pounds
	Onions		2.49/lb		2.49	pounds
	Peas			3.99/32oz	1.995	pounds
	Green Beans		4.99/lb	3.99/32oz	1.995	pounds
	Celery		3.69/lb		3.69	pounds
	Cucumber		1.49/lb		1.49	pounds
	Zucchini		2.99/lb		2.99	pounds
	Mixed veggies			3.99/32oz	1.995	pounds
	Cauliflower		2.99/lb	2.49/16oz	2.49	pounds
	Mushrooms		5.99/lb		5.99	pounds
	Bell Pepper (Green)		4.99/lb		4.99	pounds
	Bell Pepper (Other)		5.99/lb		5.99	pounds
Whole grain bread, rice, pasta	Bread		4.49/24oz		0.1870833	ounces
	Rice		6.99/5lb		1.398	pounds
	Pasta		1.49/lb		1.49	pounds
	Tortilla or Wrap		6.99/7.9oz		0.8848101	ounces
Whole Grain Cereals	Ready to Eat		3.99/16oz		0.249375	ounces
	Hot Cereal		8.99/2.5lb		3.596	pounds
Popcorn and Whole Grain	Popcorn		3.49/3-3.3oz bag		0.3525253	ounces
	Crackers		4.69/9oz		0.5211111	ounces
None whole grain variety	Bread		4.49/24oz		0.1870833	ounces
	Rice		7.49/5lb		1.498	pounds
	Pasta		1.49/16oz		1.49	pounds
	Tortilla or Wrap					
	Ready to Eat					
	Hot Cereal					
	Crackers		3.69/16oz		0.230625	ounces

Table 30. Family Consumption Patterns

Food Item	Pounds per week	oz per week
Whole grain bread/rice/cereal	7	107
Whole grain cereal	1	10
Non-whole grain products	5	76
All potato products	6	94
Dark green vegetables	6	92
Orange vegetables	5	81
Canned/dried beans & lentils	5	78
Other vegetables	10	160
Whole fruit	19	297
Fruit juices	6	94
Whole milk products	2	34
Lower fat/skim milk products	40	641
Cheese	0	2
Beef/pork products	4	56
Chicken/turkey	6	97
Fish and fish products	1	21
Nuts/nut butters	1	23
Egg and egg mixtures	1	14

Table 31. Fruit Basket price by store.

Fruit Basket Price by											
Product	**Times**	**Safeway**	**Foodland**	**Down to Earth**	**Tamura's**	**Pacific Super**	**Don Quijote**	**Costco**	**Sam's Club**	**Whole Foods**	**Food Pantry**
Whole Fruit	25.8262	21.54041	29.12415	25.56298	21.22765	22.1102	29.27898	17.4147	16.19092	24.58753	30.16153
Fruit Juice	5.885274	4.940774	6.040125	12.81952	5.88525	13.81952	11.07812	2.699274	2.4485	7.367625	6.62275
Fruit Total	31.71147	26.48119	35.164275	38.3825	27.1129	35.92972	40.3571	20.11397	18.63942	31.95516	36.78428

Product	**Marukai**	**Kokua**	**Nijiya**	**Seafood City**	**Palama**
Whole Fruit	23.9682	27.73065	28.30353	17.15553	26.44553
Fruit Juice	8.367625	14.690651	9.367625	2.935274	10.36763
Fruit Total	32.33583	42.421301	37.67116	20.09081	36.81316

Table 32. Vegetable Basket Price by store.

Vegetable Basket Price by											
Product	**Times**	**Safeway**	**Foodland**	**Down to Earth**	**Tamura's**	**Pacific Super**	**Don Quijote**	**Costco**	**Sam's Club**	**Whole Foods**	**Food Pantry**
All potato products	3.4751	3.530073	4.70022	11.7211	2.93322	3.52222	4.11711	3.531055	3.479027	8.23422	5.87822
Dark green vegetables	14.3	9.9814	18.2468	22.8228	12.5268	10.8108	18.21248	11.42094	9.9814	17.1028	20.5348
Orange vegetables	7.0751	6.09782	8.6021	9.15182	6.5661	6.0571	9.1111	3.04891	4.35704	5.921367	10.1291
Other vegetables	18.45653	22.42755	20.404575	23.3766	10.117373	7.471686	23.16847	16.94804	18.01197	15.3846	21.3786
Total	43.30673	42.03684	51.953695	67.07232	32.143493	27.86181	54.60916	34.94894	35.82944	46.64299	57.92072

Product	**Marukai**	**Kokua**	**Nijiya**	**Seafood City**	**Palama**
All potato products	3.16882	14.6661	7.0091	3.52222	4.0641
Dark green vegetables	11.9548	21.1068	20.5348	14.8148	17.1028
Orange vegetables	5.0391	15.2191	8.8566	6.5661	5.5481
Other vegetables	22.8771	26.8731	24.8751	9.94005	4.978352
Total	43.03982	77.8651	61.2756	34.84317	31.69335

Table 33. Grain Basket Price by Store.

Grain Basket Price by											
Product	**Times**	**Safeway**	**Foodland**	**Down to Earth**	**Tamura's**	**Pacific Super**	**Don Quijote**	**Costco**	**Sam's Club**	**Whole Foods**	**Food Pantry**
Whole grain product	5.377195	3.532244	5.316747955	7.816785	3.97677906	5.613013	9.331955	3.381945	3.11416	7.305456	4.107053
Whole grain hot cereal	1.17859	0.86552	1.414780952	0.6758	1.17859048	1.17859	1.17859	0.53878	0.51274	2.22952	1.769067
Non-Whole Grain	3.775494	2.337	3.786289773	7.355078	2.59948839	3.048936	3.356592	4.276336	1.386466	5.558786	2.914273
Grain Total	10.33128	6.734764	10.51781868	15.84766	7.75485793	9.84054	13.86714	8.197061	5.013366	15.09376	8.790393

Product	**Marukai**	**Kokua**	**Nijiya**	**Seafood City**	**Palama**
Whole grain product	5.467107	11.8134038	10.15639	5.271271	5.992995
Whole grain hot cereal	1.096711	0.8618	3.22952	1.17859	2.096711
Non-Whole Grain	3.893367	13.7167045	7.227291	3.64325	5.163761
Grain Total	10.45719	26.3919083	20.6132	10.09311	13.25347

Table 34. Protein Basket Price by Store.

Meat/Protein Basket Price											
Product	**Times**	**Safeway**	**Foodland**	**Down to Earth**	**Tamura's**	**Pacific Super**	**Don Quijote**	**Costco**	**Sam's Club**	**Whole Foods**	**Food Pantry**
Beef, pork, veal, lamb	14.044	14.0448	17.5648	42.2048	17.5648	9.8208	10.5248	7.0048	10.4896	24.6048	19.3248
Poultry	15.039	24.0996	25.3076	84.4996	32.5556	18.0596	19.54544	17.10327	13.1672	42.2196	36.07893
Fish	7.030	5.3664	8.6944	33.06856	5.3664	6.1984	7.8624	3.216571	4.46784	8.2784	8.32
Legumes, meat alternatives	13.35669	16.27392	11.736	12.79783	9.4446857	9.444686	11.12126	8.927743	8.194611	11.12126	13.22256
Nuts	6.091	6.99776	7.6538	9.454044	5.3818	5.6658	5.3818	4.255943	9.2584	4.411467	8.3638
Egg and egg mixtures	7.3	7.98	4.786666667	13.58	8.792	8.792	9.98	5.053333	6.96	9.38	7.98
Protein Total	62.94329	74.76248	75.74326667	195.6048	79.105286	57.98129	64.4157	45.56166	52.53765	100.0155	93.29009

Product	**Marukai**	**Kokua**	**Nijiya**	**Seafood City**	**Palama**
Beef, pork, veal, lamb	12.6368	26.3648	38.6848	14.0448	17.5648
Poultry	34.3676	69.3996	78.4596	24.0996	84.4996
Fish	5.3664	11.6064	12.26856	6.6144	3.107
Legumes, meat alternatives	12.44016	11.69688	15.59584	11.12126	11.65776
Nuts	10.59004	8.9318	32.17404	7.0858	32.17404
Egg and egg mixtures	5.98	11.58	10.58	6.58	13.58
Protein Total	81.381	139.57948	187.7628	69.54586	162.5832

Table 35. Milk Basket Price by Store.

Milk Basket Price by											
Product	**Times**	**Safeway**	**Foodland**	**Down to Earth**	**Tamura's**	**Pacific Super**	**Don Quijote**	**Costco**	**Sam's Club**	**Whole Foods**	**Food Pantry**
Whole milk	1.861088	1.328588	1.7013375	4.201425	1.5948375	1.541588	1.514963	1.142213	1.13955	2.127338	1.754588
Nonfat milk	13.98	11.36	12.78	31.56	11.98	10.98	11.38	7.9	7.9	15.98	13.18
Cheese	0.71435	0.64935	0.78585	1.5834	0.8177	0.7787	0.64935	0.27274	0.27274	0.916933	1.1934
TOTAL	16.55544	13.33794	15.2671875	37.34483	14.3925375	13.30029	13.54431	9.314953	9.31229	19.02427	16.12799

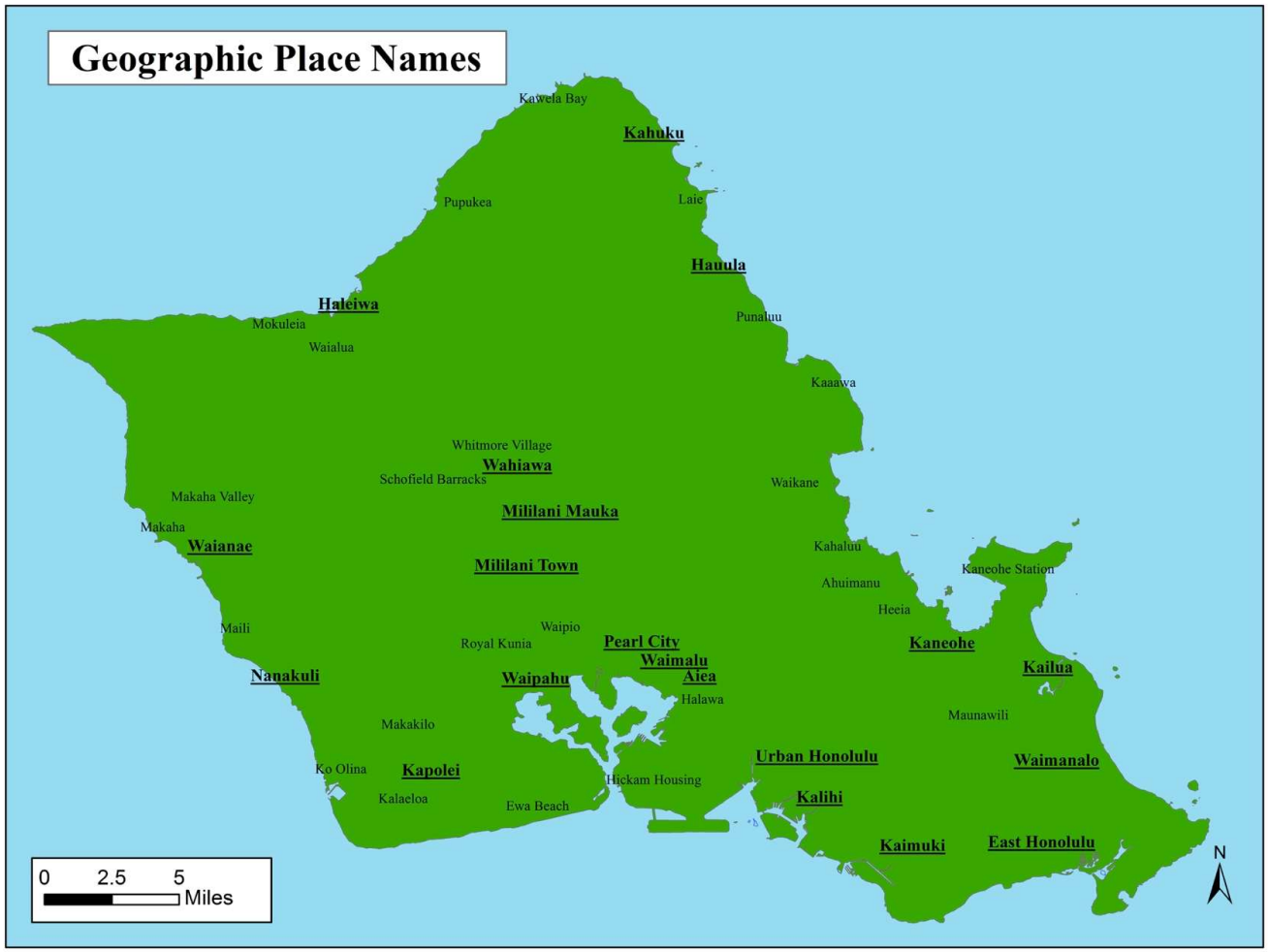
Product	**Marukai**	**Kokua**	**Nijiya**	**Seafood City**	**Palama**
Whole milk	2.020838	3.455925	3.189675	1.594838	5.201425
Nonfat milk	15.18	25.96	23.96	10.98	32.56
Cheese	1.2974	0.6877	1.556533	2.556533	3.556533
TOTAL	18.49824	30.103625	28.70621	15.13137	41.31796

Table 36. Total Basket Price by Store.

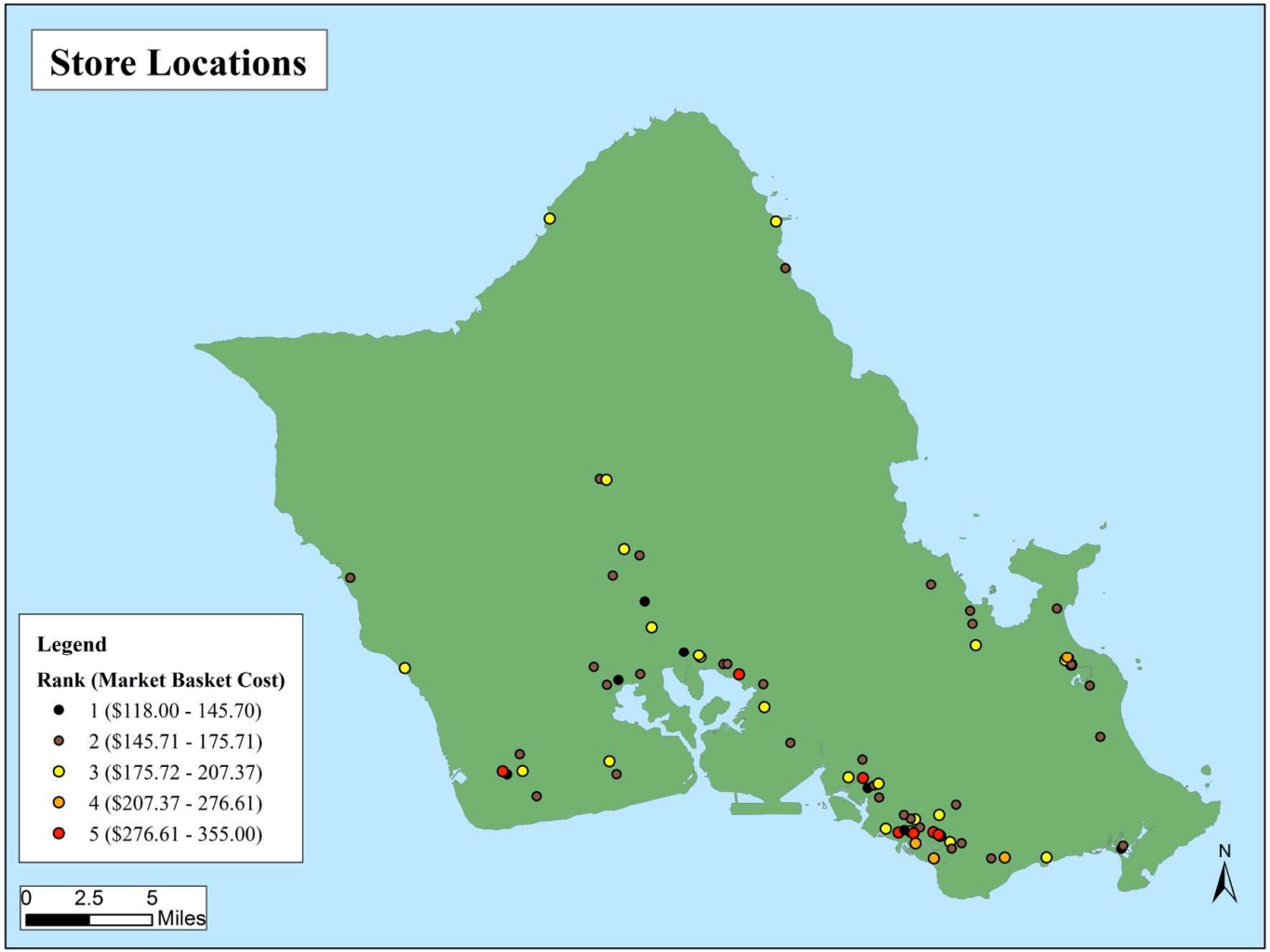
Product	Times	Safeway	Foodland	Down to Earth	Tamura's	Pacific Super	Don Quijote	Costco	Sam's Club
Protein Total	62.94328571	74.76248	75.74326667	195.6048309	79.105286	57.98128571	64.41569714	45.56165714	52.53765053
Grain Total	10.33127962	6.734763963	10.51781868	15.84766335	7.7548579	9.840539851	13.86713766	8.197060967	5.013366094
Milk Total	16.5554375	13.3379375	15.2671875	37.344825	14.392538	13.3002875	13.5443125	9.3149525	9.31229
Fruit Total	31.7114736	26.48118753	35.164275	38.38250333	27.1129	35.92972	40.35710098	20.11397411	18.63942167
Vegetable Total	43.306725	42.03684333	51.953695	67.07232	32.143493	27.86180584	54.60916334	34.94893524	35.82943667
Total Basket Cost	164.8482014	163.3532123	188.6462428	354.2521426	160.50907	144.9136389	186.7934116	118.13658	121.332165

Product	Whole Foods	Food Pantry	Marukai	Kokua	Nijiya	Seafood City	Palama
Protein Total	100.0155238	93.29009132	81.38100444	139.57948	187.7628424	69.54585714	162.5832044
Grain Total	15.09376292	8.790392604	10.45718549	26.391908	20.61320419	10.09311116	13.25346674
Milk Total	19.02427083	16.1279875	18.4982375	30.103625	28.70620833	15.13137083	41.31795833
Fruit Total	31.95515833	36.78428333	32.335825	42.421301	37.67115833	20.09080693	36.81315833
Vegetable Total	46.64298667	57.92072	43.03982	77.8651	61.2756	34.84317	31.69335167
Total Basket Cost	212.7317026	212.9134748	185.7120724	316.36141	336.0290132	149.7043161	285.6611395

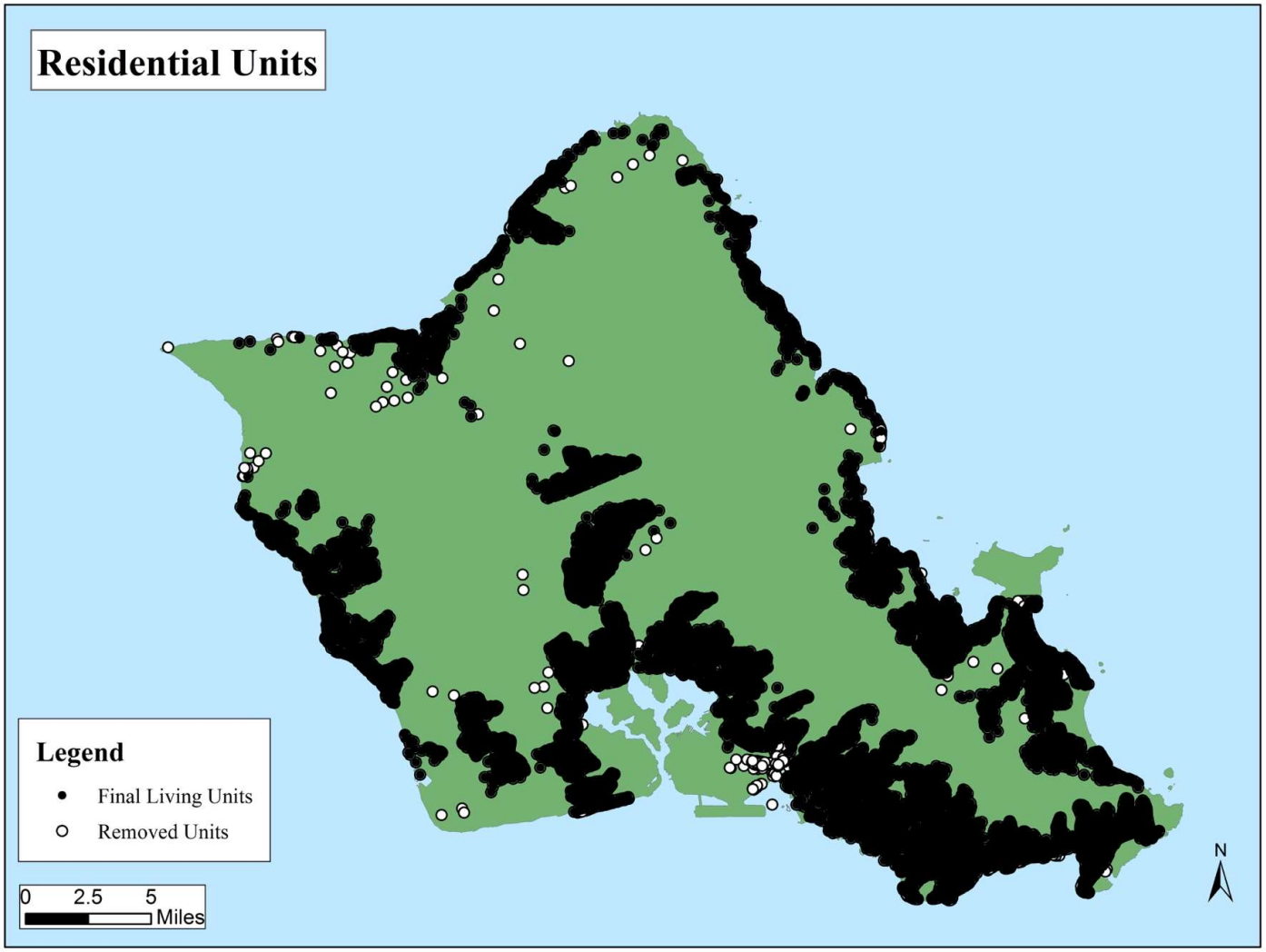
APPENDIX C. MAPS



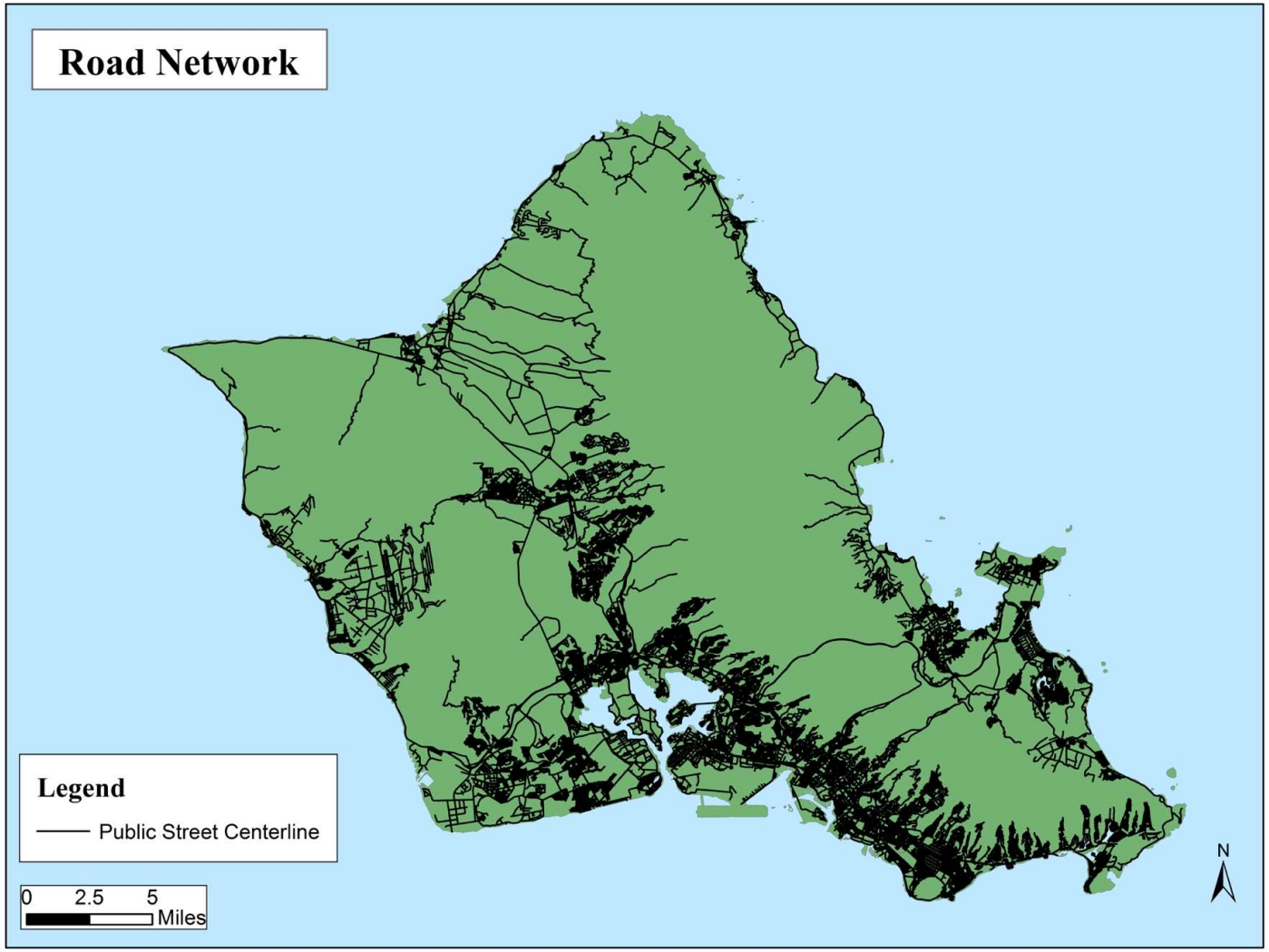
Map 2.


Store Locations
Legend
Rank (Market Basket Cost)
1 ($118.00 - 145.70)
2 ($145.71 - 175.71)
3 ($175.72 - 207.37)
4 ($207.37 - 276.61)
5 ($276.61 - 355.00)
0 2.5 5
Miles
N

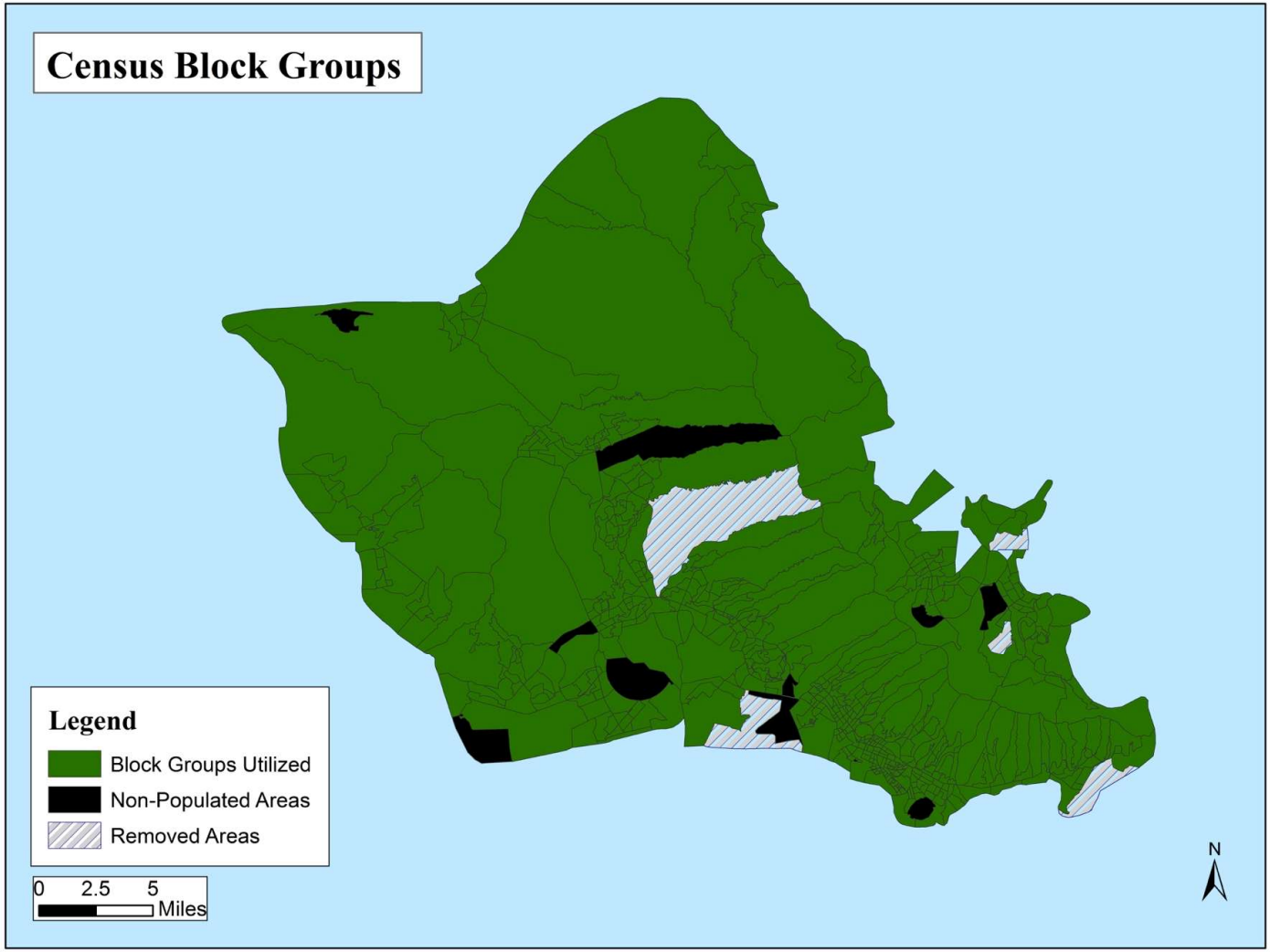
Map 3.


Residential Units
Legend
Final Living Units
Removed Units
0 2.5 5
Miles
N

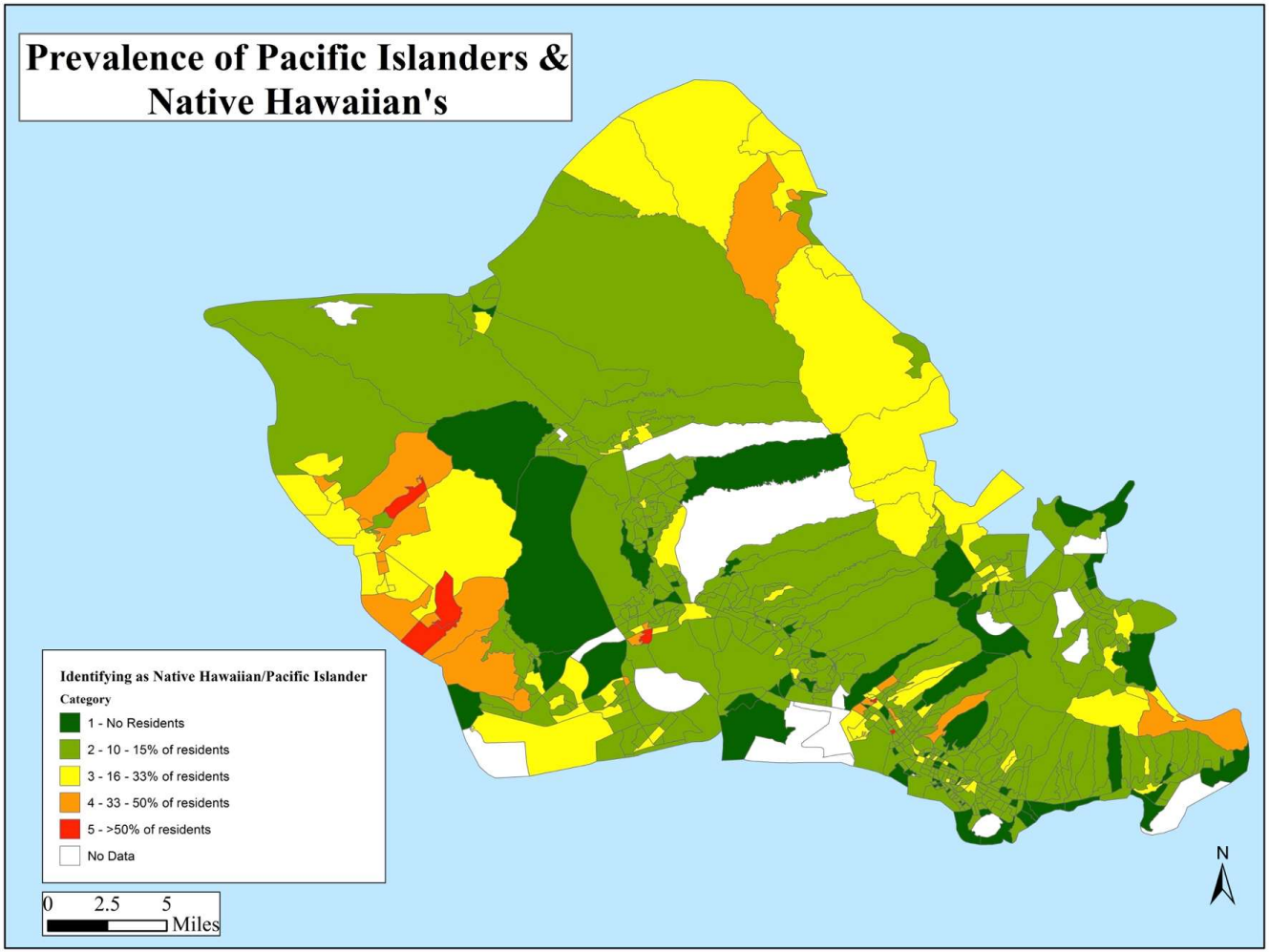
Map 4.



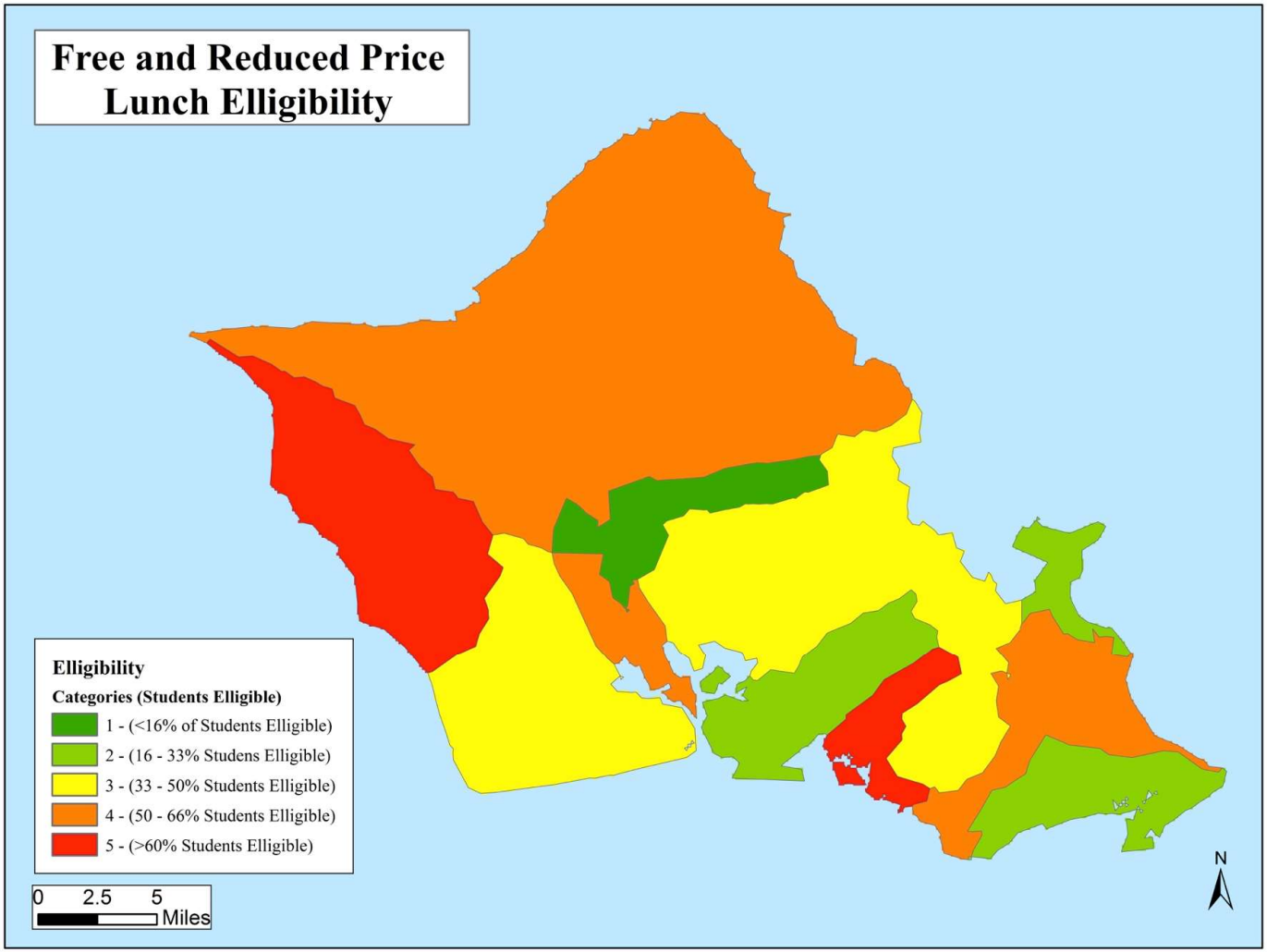
Map 5.


Census Block Groups
Legend
Block Groups Utilized
Non-Populated Areas
Removed Areas
0 2.5 5
Miles
N

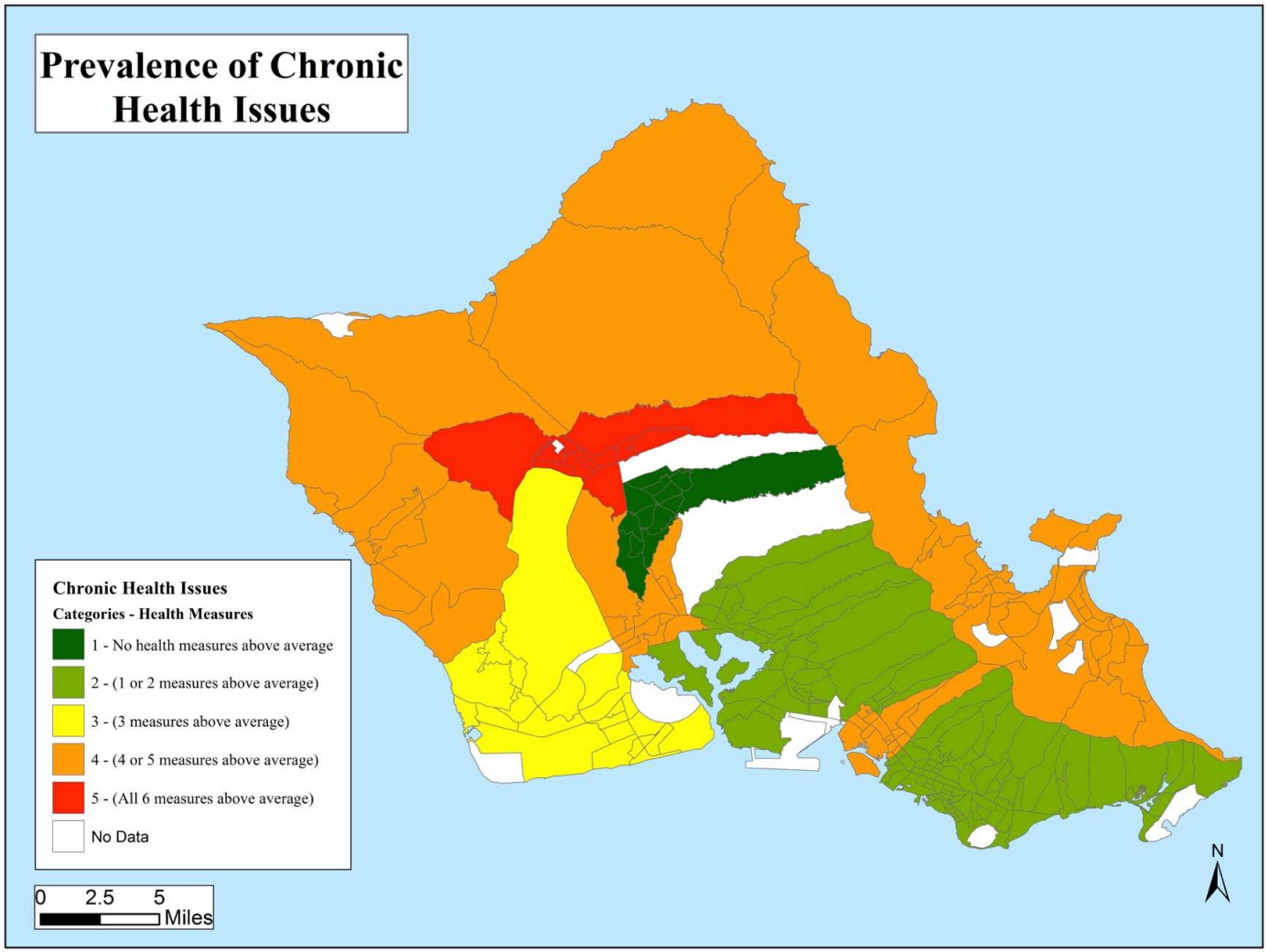
Map 6.


Prevalence of Pacific Islanders &
Native Hawaiian's
Identifying as Native Hawaiian/Pacific Islander
Category
1 - No Residents
2 - 10 - 15% of residents
3 - 16 - 33% of residents
4 - 33 - 50% of residents
5 - >50% of residents
No Data
0 2.5 5
Miles
N

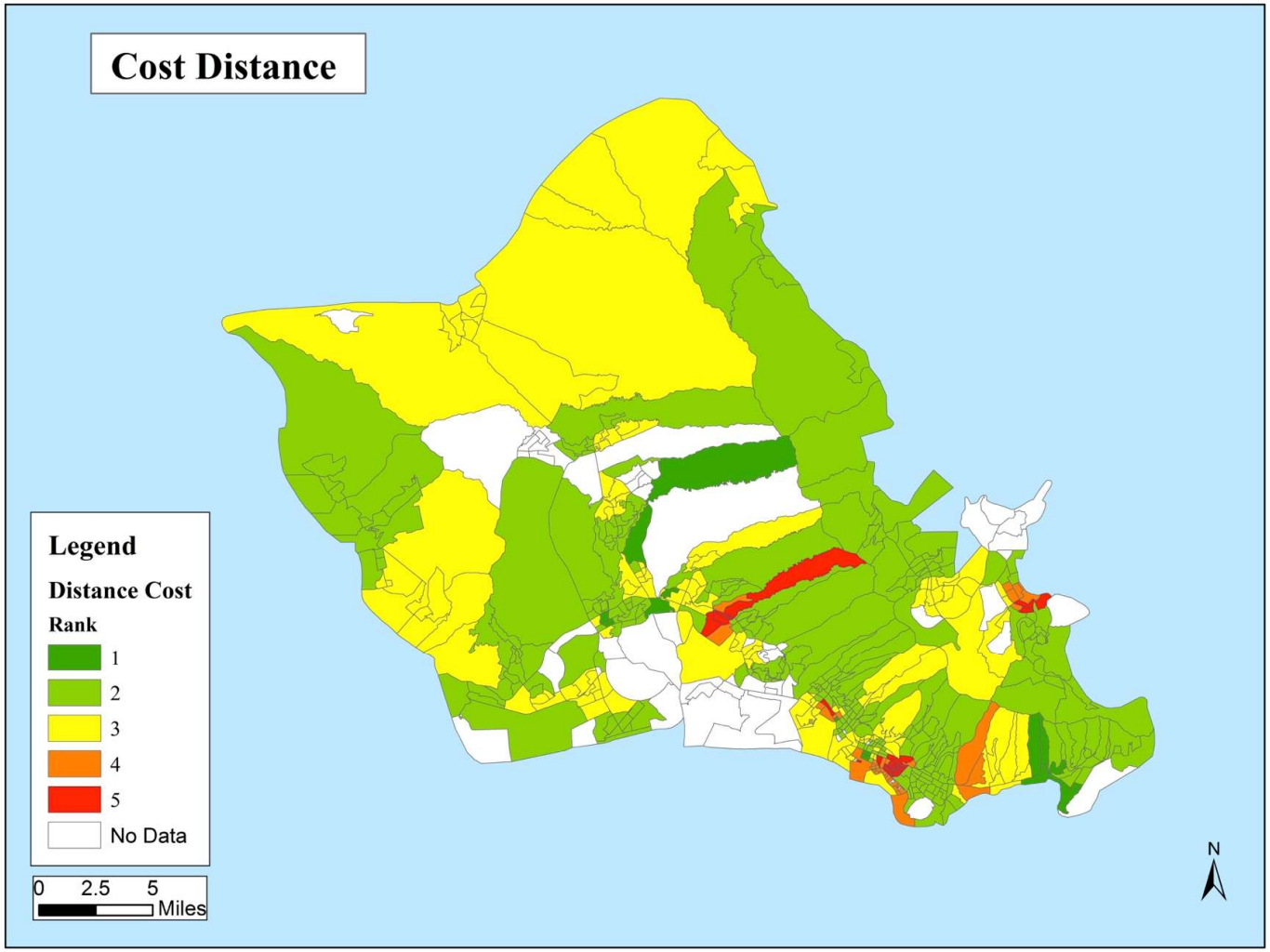
Map 7.


Free and Reduced Price Lunch Elligibility
Elligibility
Categories (Students Elligible)
1 - (<16% of Students Elligible)
2 - (16 - 33% Studens Elligible)
3 - (33 - 50% Students Elligible)
4 - (50 - 66% Students Elligible)
5 - (>60% Students Elligible)
0 2.5 5
Miles
N

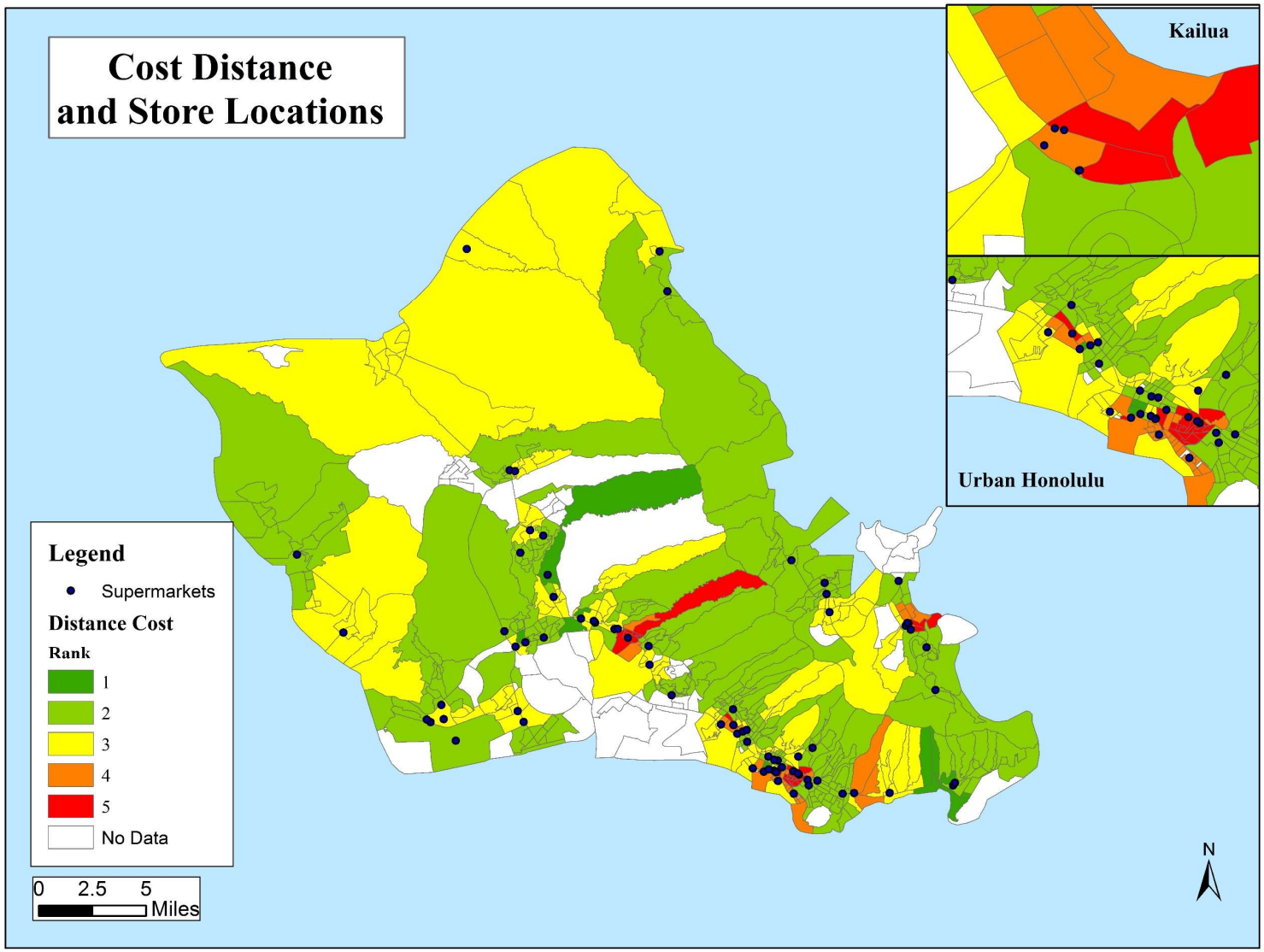
Map 8.


Prevalence of Chronic Health Issues
Chronic Health Issues
Categories - Health Measures
1 - No health measures above average
2 - (1 or 2 measures above average)
3 - (3 measures above average)
4 - (4 or 5 measures above average)
5 - (All 6 measures above average)
No Data
0 2.5 5
Miles
N

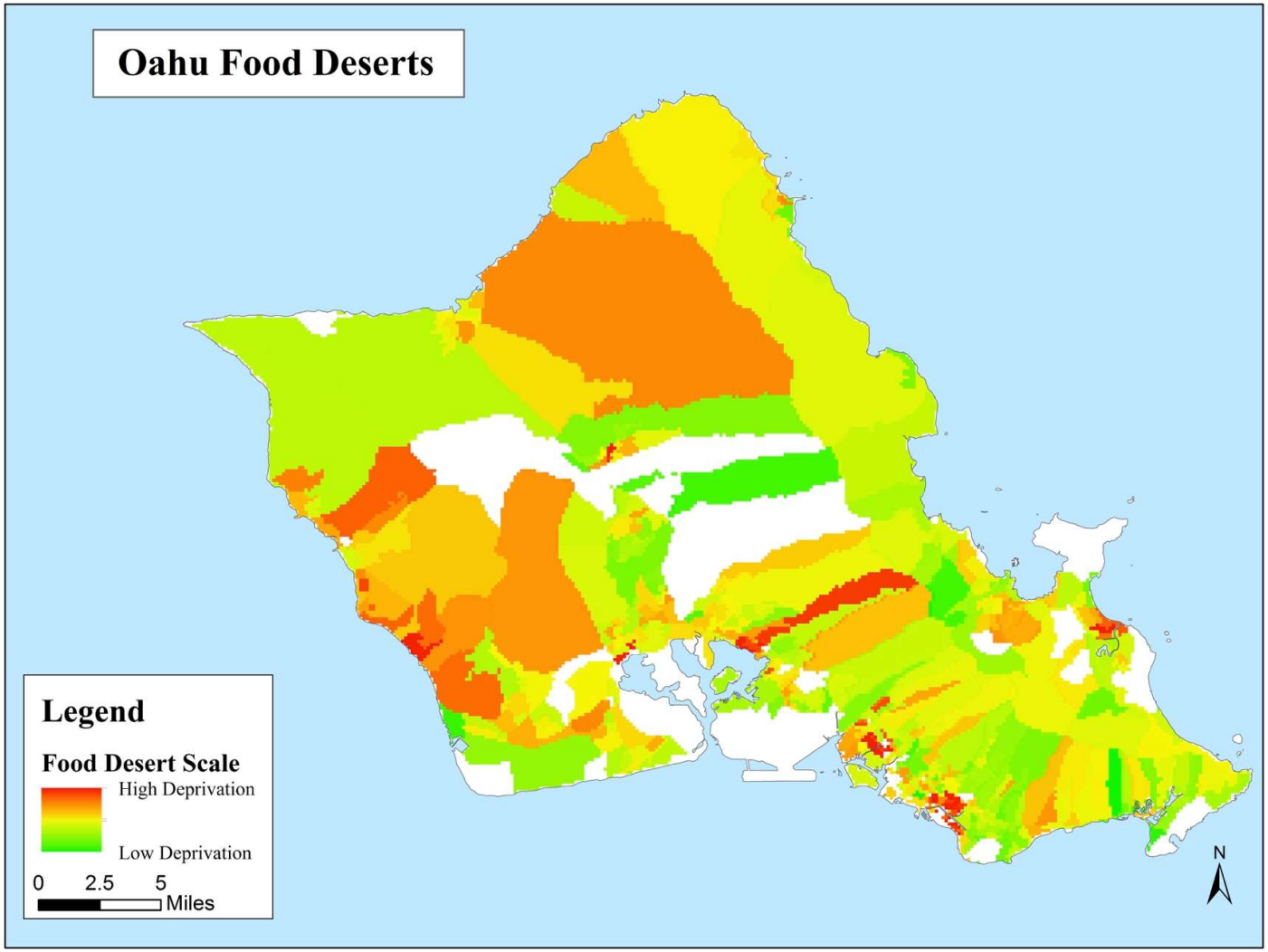
Map 9.


Cost Distance
Legend
Distance Cost
Rank
1
2
3
4
5
No Data
0 2.5 5
Miles
N

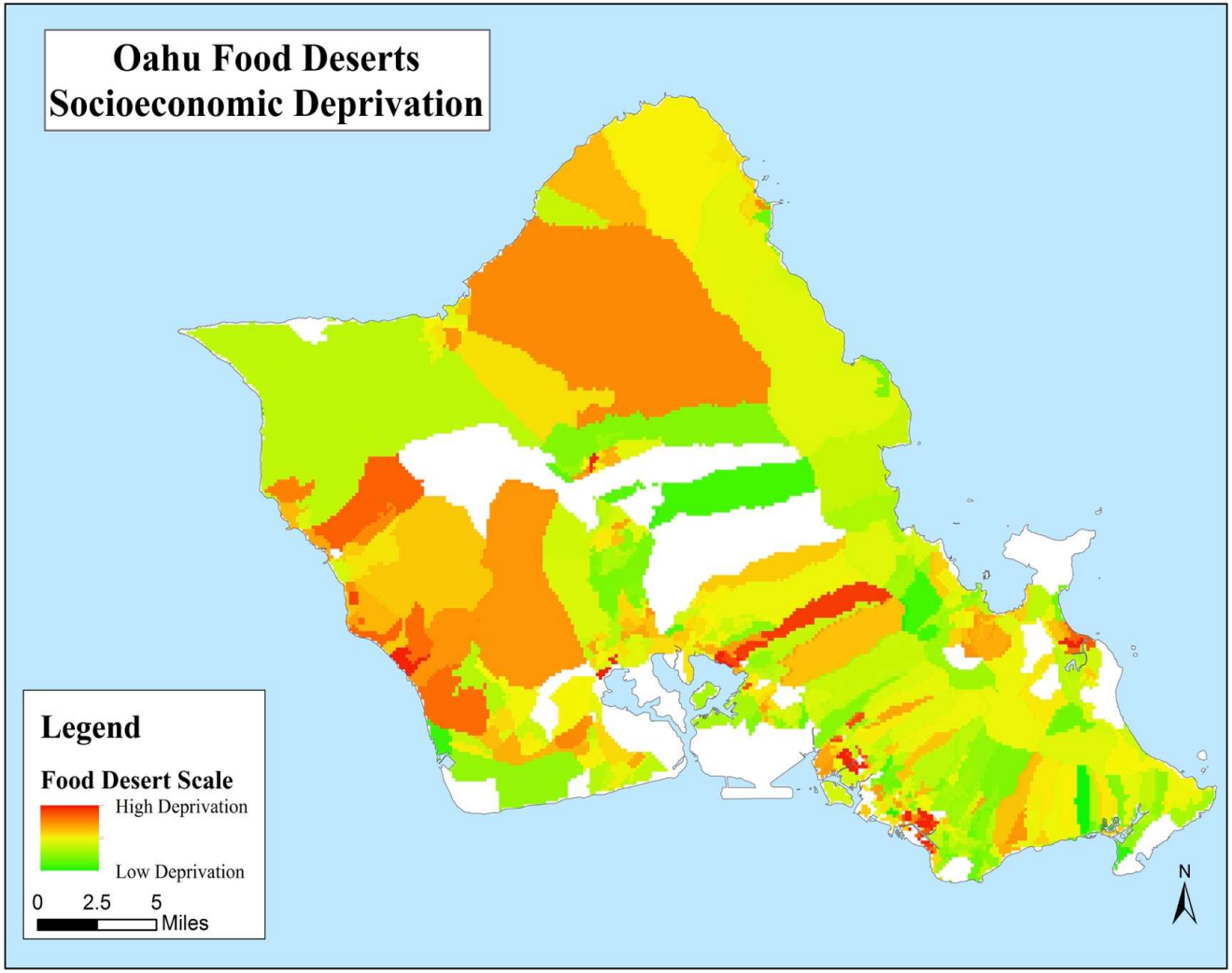
Map 10.


Cost Distance
and Store Locations
Kailua
Urban Honolulu
Legend
Supermarkets
Distance Cost
Rank
1
2
3
4
5
No Data
0 2.5 5
Miles
N

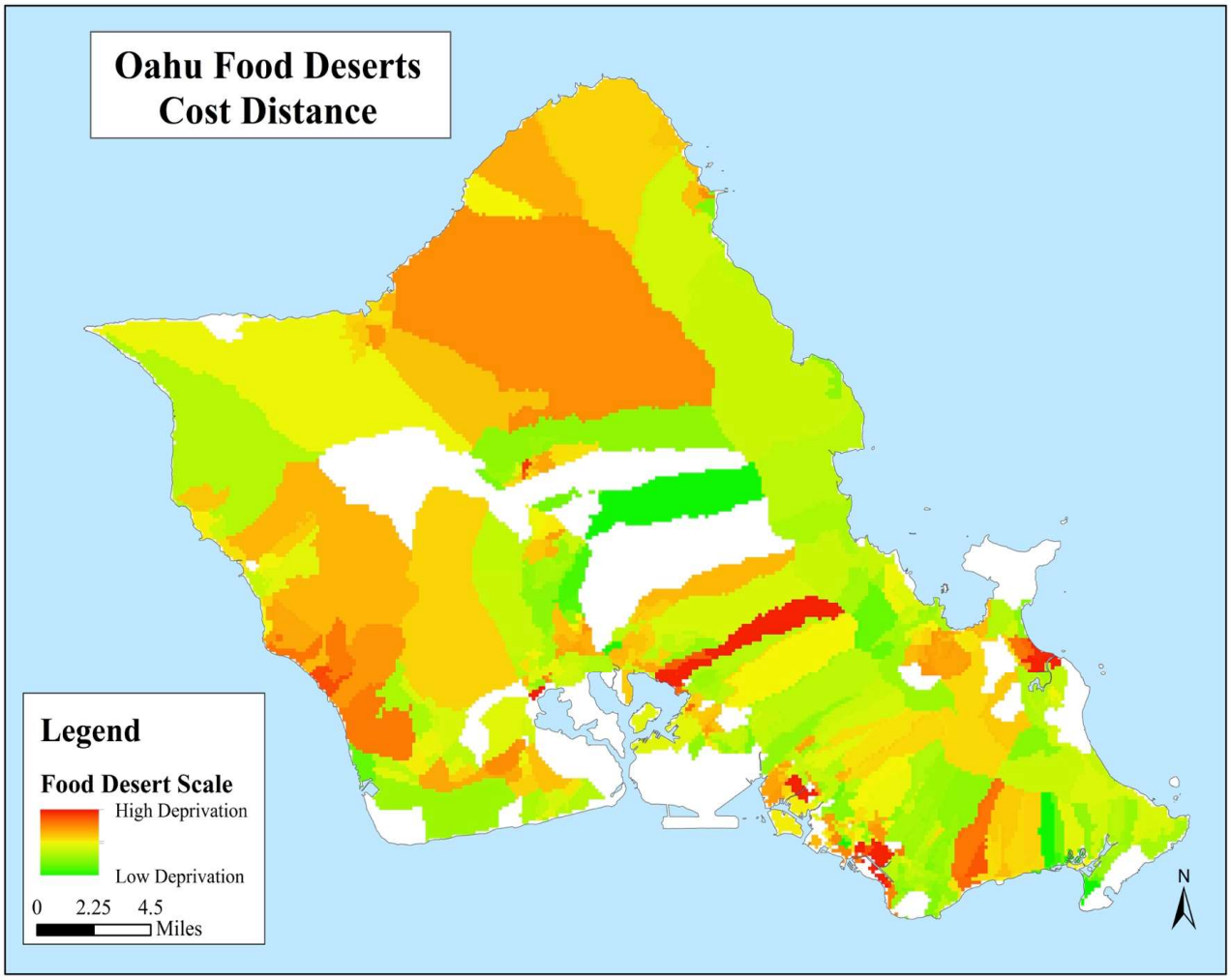
Map 11.


Oahu Food Deserts
Legend
Food Desert Scale
High Deprivation
Low Deprivation
0 2.5 5
Miles
N

Map 12.


Oahu Food Deserts
Socioeconomic Deprivation
Legend
Food Desert Scale
High Deprivation
Low Deprivation
0 2.5 5
Miles
N

Map 13.


Oahu Food Deserts
Cost Distance
Legend
Food Desert Scale
High Deprivation
Low Deprivation
0 2.25 4.5
Miles
N

Map 14.

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